CHAPTER 4

JP-5 AFLOAT BELOW DECKS SYSTEMS AND OPERATIONS

The first time you see the pump room of a CV/CVN, it is easy to be intimidated. With its complex array of piping, pumps, valves, gages, and motors, you may feel there is just too much to learn. But the qualified pump-room operators make it look easy.

In this chapter, we will try to ease you through this complex system by breaking it down. First we will discuss the subsystems; then we will cover the many components that make up these systems; and finally we will explain operational procedures.

To operate any JP-5 fueling system safely and efficiently, the ABF must have a thorough knowledge of the arrangement and limitations of the piping systems. Although the piping arrangements are similar for all CV/CVNs, no two ships (not even sister ships) are exactly alike. Therefore, you should consult your ship's blueprints and Ships Information Book (SIB) for details on its particular system. The information and diagrams in this chapter are based on the typical arrangements of various class carriers, small or large, and old or new.

JP-5 FUELING SYSTEM

LEARNING OBJECTIVE: Identify the subsystems that make up a JP-5 fueling system.

A JP-5 fueling system consists primarily of a storage system and three separate and independent pumping systems. The pumping systems are Filling and Transfer, Stripping, and Service. The tanks in a JP-5 system are designated under two major categories: storage and service. Storage tanks are used for bulk storage of JP-5. Service tanks are used for servicing aircraft. The storage capacity of different classes of ships depends on the number and size of the ship's tanks. Approximate storage capacities for some of the different classes of ships are listed in table 4-1.

Table 4-1.—JP-5 Storage Capacities

CLASS SHIP	APPROXIMATE CAPACITY
LPD-3 (LA SALLE)	1/4 million gallons
LPH-2 (IWO JIMA)	1/4 million gallons
CV-60 (SARATOGA)	1 1/2 million gallons
CV-63 (KITTY HAWK)	1 3/4 million gallons
CVN-65 (ENTERPRISE)	2 1/4 million gallons
CV-66 (AMERICA)	2 1/4 million gallons
CV-67 (JOHN F. KENNEDY)	2 1/2 million gallons
CVN-68 (NIMITZ)	3 million gallons
CVN-71 (ROOSEVELT)	3 1/4 million gallons

Due to the difference in the types of valves, pumps, filters, and other equipment installed on various ships, this section will use general descriptions. While your ship may have a gate valve in a specific location, another ship may use a buttefly or limitorque valve in the same location. Therefore, we will use the terms *cutout valve, discharge valve, filter,* etc. Specific components will be discussed in the next section.

FILLING AND TRANSFER SYSTEM

The filling and transfer system (fig. 4-1), and its interconnecting piping and valves, serves many functions in the operation of the JP-5 fueling system. It is used primarily for receiving JP-5 aboard to fill the storage tanks; transferring JP-5 from storage to service tanks; transferring JP-5 internally from forward to aft or port to starboard (or vice versa); and filling the amidship emergency tanks (on ships so equipped) when JP-5 is required for boiler fuel. It is also used to receive and direct JP-5 from the independent defuel main to a preselected storage tank, and to receive JP-5 from the stripping pump discharge header and direct it to any storage tank for consolidation. Off-loading of JP-5 is accomplished by the service pumps through cross-connection piping to the filling and transfer system.

Filling System

The filling system includes all piping, valves, and related equipment from the filling connections on the main deck to the fill and suction tailpipe in the storage tanks.

The main-deck filling connections provide a means of attaching the refueling hose to the ship and controlling the quality and quantity of JP-5 being received. They are located on the starboard side of the main deck, outboard of the hangar deck, on fueling sponsons, or in elevator ramp recesses. The number of filling connections varies, depending on the type and class carrier. Most carriers have additional filling connections on the port side to enable refueling from a barge when moored to a pier.

The probe fueling rig is the standard fitting used at the starboard-side filling connections for underway replenish merits. It consists of a fueling probe and a probe receiver. The receiver is supported by a swivel fitting mounted on the receiving ship. A 7-inch-diameter, wire-reinforced rubber hose connects the receiver to the filling connection.

The port-side filling connections use flanges to bolt the refueling hose to the connection.

Filling connections begin with a 90° elbow and a stop valve. A flushing line is installed outboard of the fill connection stop valve on some carrier and amphibious aviation-type ships. It is used for hose flushing and to receive the initial flow during refueling. The flushing line directs fuel flow to the reclamation system and into contaminated storage tanks through the defueling main. All filling connections should be equipped with the following:

1. A sampling connection, to determine the quality of fuel being received.

2. A pressure gage, to determine the discharge pressure from the refueling source.

3. A low-pressure air connection, for blowing JP-5 in the hose back to the refueling source (if necessary).

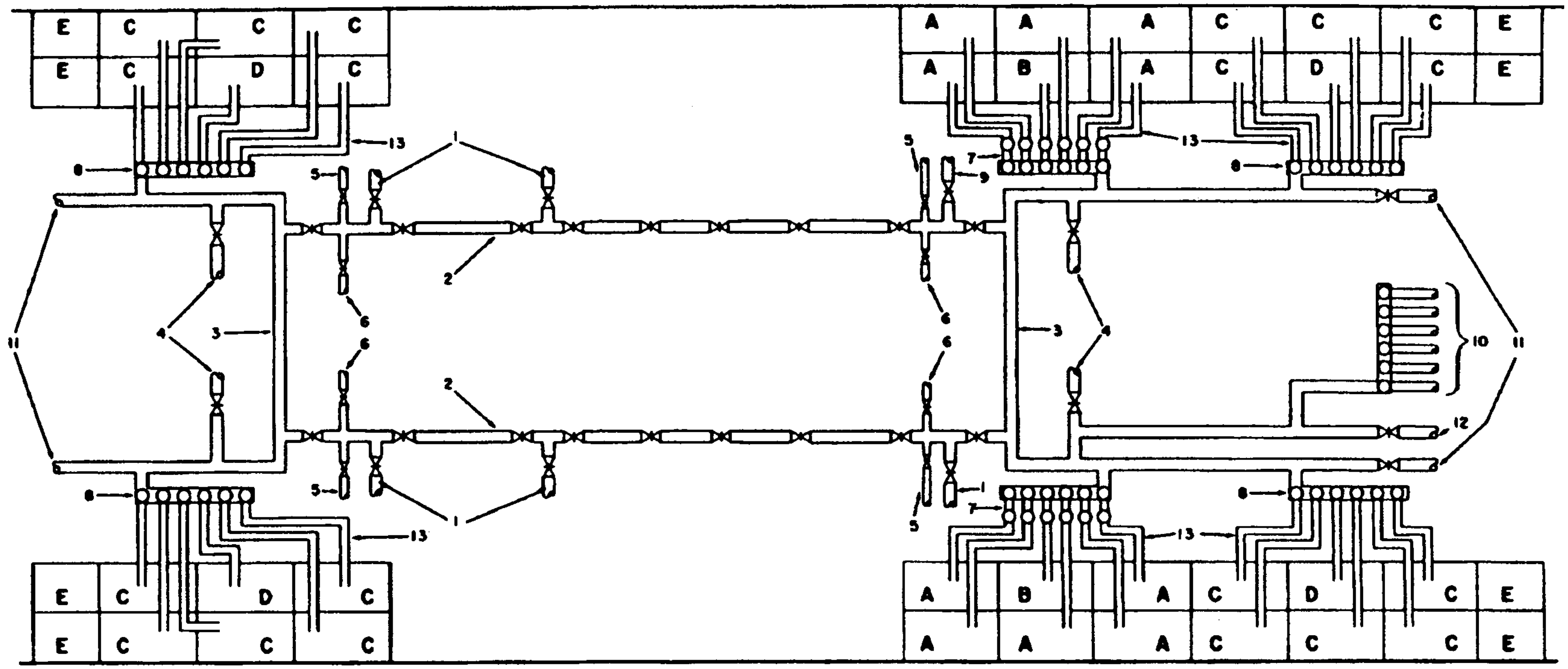
The downcomer is that section of piping that connects the filling connection on the main deck with the transfer main on the seventh deck. There is normally one downcomer for each filling connection installed.

The transfer main runs fore and aft through the bilge just below the seventh deck. New CV/CVNs have a dual transfer main that runs forward and aft on both the port and starboard sides, creating a “closed loop” transfer main. The transfer main interconnects the forward and aft group of storage tanks, and the amidship emergency tanks (on ships so equipped). In addition to being connected to the downcomers, it is also connected to the independent defuel main and the discharge headers of the transfer and stripping pumps.

Cutout valves are installed at strategic points throughout the transfer main, mostly at fore and aft bulkheads. These valves are used to isolate the system during the secured condition and to control the flow of JP-5 during various transfer and filling operations. Each valve is unclassfifed or Damage Control marked ⊗-ray.

The extreme forward and aft ends of the transfer main are connected to the transfer-main branch headers. The transfer-main branch headers extend outboard from the transfer main and interconnect the storage tank manifolds with the transfer main. Normally there are only two branch headers for each of the forward and aft groups of tanks: one port and one starboard. But on ships with double bottom and peak tanks for JP-5 storage. additional branches are required.

Located between the transfer-main branch headers and the storage tank fill and suction tailpipes are valve manifolds. All manifold valves are Damage Control marked ⊗-ray and MUST be closed when not actually in use.



A. JP-5 or ballast
B. JP-5, ballast, or overflow
C. JP-5
D. JP-5 or overflow
E. JP-5 service
1. Downcomers
2. Transfer main
3. Transfer-main branch headers
4. Transfer-pump suction headers
5. Transfer pump discharge
6. Stripping pump discharge
7. Double-valved manifold
8. Single-valved manifold
9. Defuel main
10. Double-bottom tank fill lines
11. Transfer-main branch headers (to other storage tanks)
12. Transfer-main branch header (to peak tank)
13. Storage-tank fill and suction lines

Figure 4-1.—Typical JP-5 filling and transfer system.

Transfer System

The transfer system discussed here is a typical arrangement using three transfer pumps and two centrifugal purifiers in each pump room. See figure 4-2.

The suction header, common to all three transfer pumps, is connected directly to the port and starboard transfer-main branch headers. The two valves installed in the suction header, one port and one starboard, permit the transfer pumps to take suction either from the port or starboard storage tanks independently or from both at the same time.

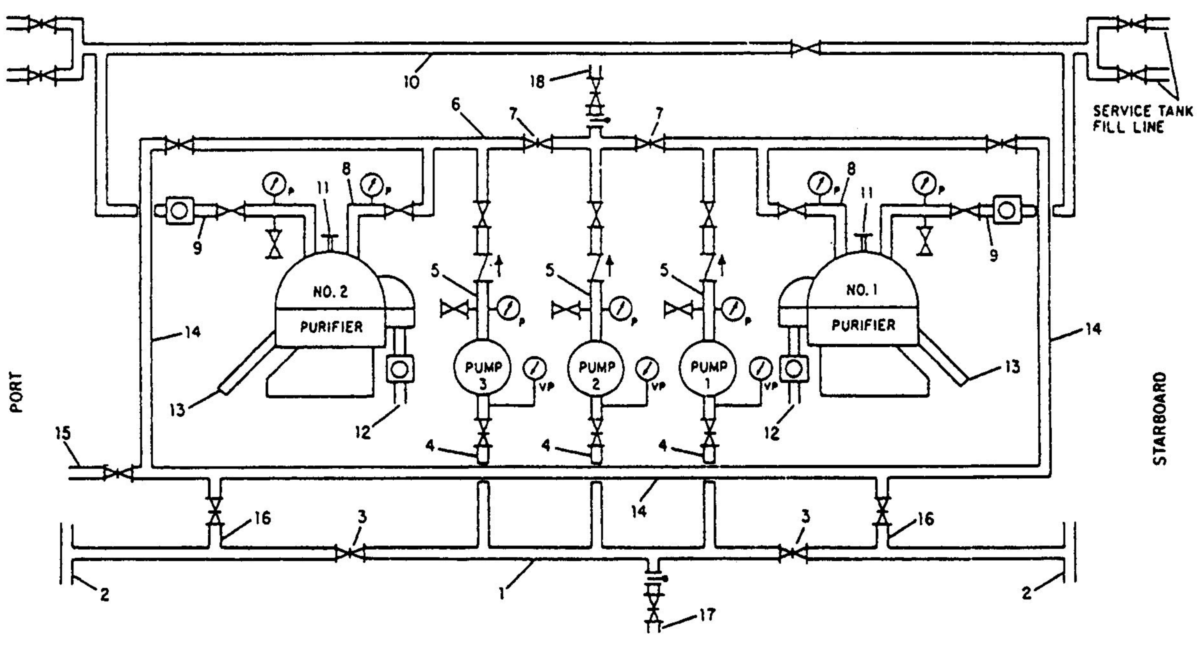
Three pump inlet lines connect the common suction header with the suction side of the transfer pumps. Each line contains an inlet valve and a compound gage.

The transfer pumps discharge into a common discharge header. Each pump discharge line contains a test connection, pressure gage, one-way check valve, and a discharge valve.

Two cutout valves are arranged in the discharge header (one between each pump discharge line) to enable both purifiers to be in operation simultaneously, using any two of the three transfer pumps. For instance, when pump 1 is aligned with purifier No. 1, either pump 2 or pump 3 can be aligned with purifier No. 2. When pump 3 is aligned with purifier No. 2, either pump 1 or pump 2 can be aligned with purifier No. 1. **Never align more than one transfer pump to only one purifier.**

This valve arrangement also permits two separate transfer operations to be performed simultaneously. For example, if pump 1 is aligned with purifier No. 1 to top off a service tank, pumps 2 and 3 can be used to transfer JP-5 from forward to aft, reclaim fuel, and so forth. The same applies for pumps 1 and 2 when pump 3 is being used with purifier No. 2.

Purifiers are bypassed for all transfer operations except when service tanks are being filled. The bypass lines extend off the extreme ends of the transfer-pump discharge header and are connected to the transfer main. Cutout valves separate the bypass lines from the discharge header. Two valved crossovers (one port and one starboard), interconnect the bypass line with the common suction header of the transfer pumps. The cross-overs are used to align the transfer system for pumping JP-5 from port to starboard, or vice versa. The purifier bypass line is also used when transferring JP-5 from



1. Suction header
2. Main branch headers
3. Suction-header control valves
4. Pump inlet
5. Pump discharge
6. Discharge header
7. Discharge-header control valves
8. Purifier inlet
9. Purifier discharge
10. Service-tank fill line header
11. Seal water inlet
12. Purifier water discharge
13. Purifier casing drain
14. Purifier bypass
15. Transfer-main connection
16. Suction header crossover to bypass
17. Cross-connection to service-pump suction header
18. Cross-connection to service-pump discharge header

Figure 4-2.—Typical transfer system.

forward to aft (or vice versa), when filling amidship emergency tanks (on ships so equipped), and when off-loading JP-5.

The common suction and discharge headers of the transfer pumps are interconnected with the suction and discharge headers of the service pumps. This arrangement enables the service pumps to be used as transfer pumps (normally for off-loading JP-5). Be-cause of insufficient (static) head lift and the low pumping capacity of the transfer pumps, they are not normally used for transferring JP-5 off the ship. The cross-connections between the respective suction and discharge headers are fitted with a spectacle flange or a line blind valve (blank side in), and a cutout valve (normally locked closed).

Reclamation System

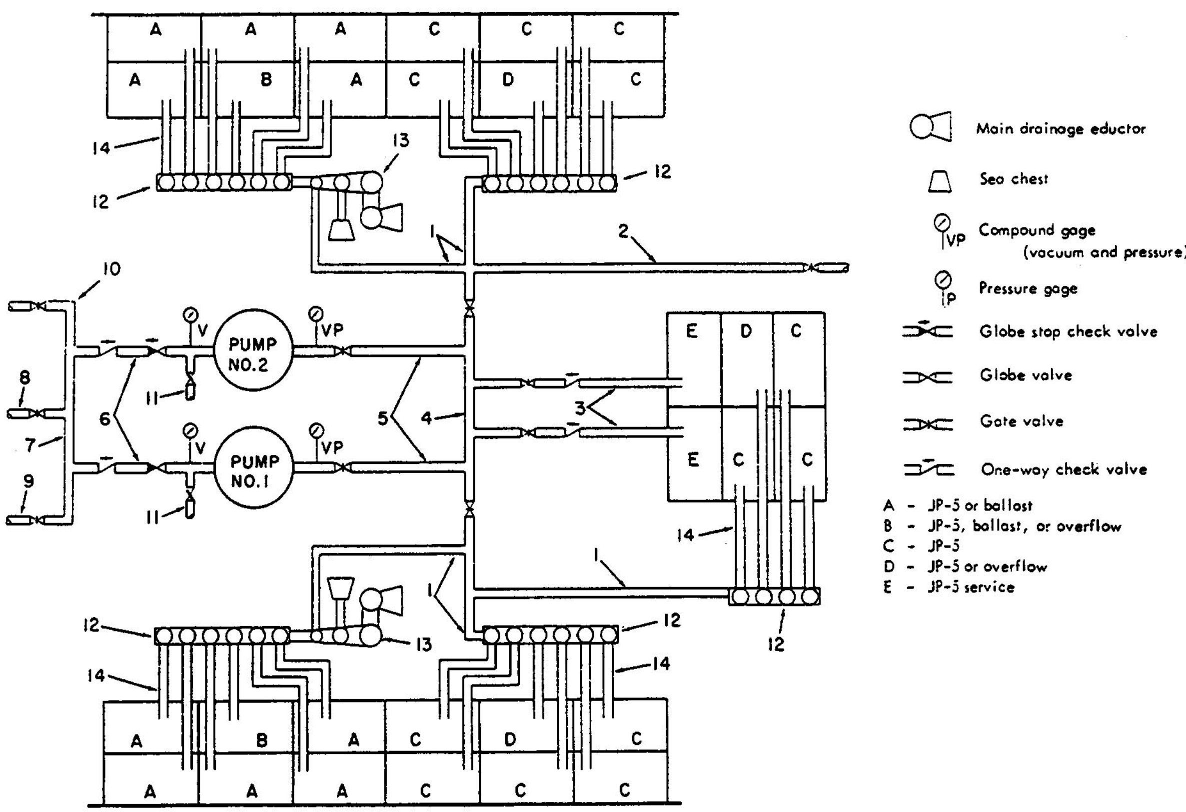
The reclamation system provides the capability to reclaim JP-5 received from hose flushings, JP-5 tank stripping operations, and the initial flow during a fueling at sea (FAS). The water and sediment received from these operations are permitted to settle out in the contaminated-JP-5 settling tanks. JP-5 drawn off by the designated JP-5 transfer pump is discharged through the reclamation prefilter and fiber/separator and then into JP-5 storage tanks.

STRIPPING SYSTEM

There are two independent stripping systems in each JP-5 pump room. One system uses motor-driven pumps and is interconnected with all JP-5 tanks (both storage and service). The other system uses hand-operated pumps and is installed in service tanks only. The systems we will describe here are the typical setup for one pump room. Since they operate independently, we will describe each separately.

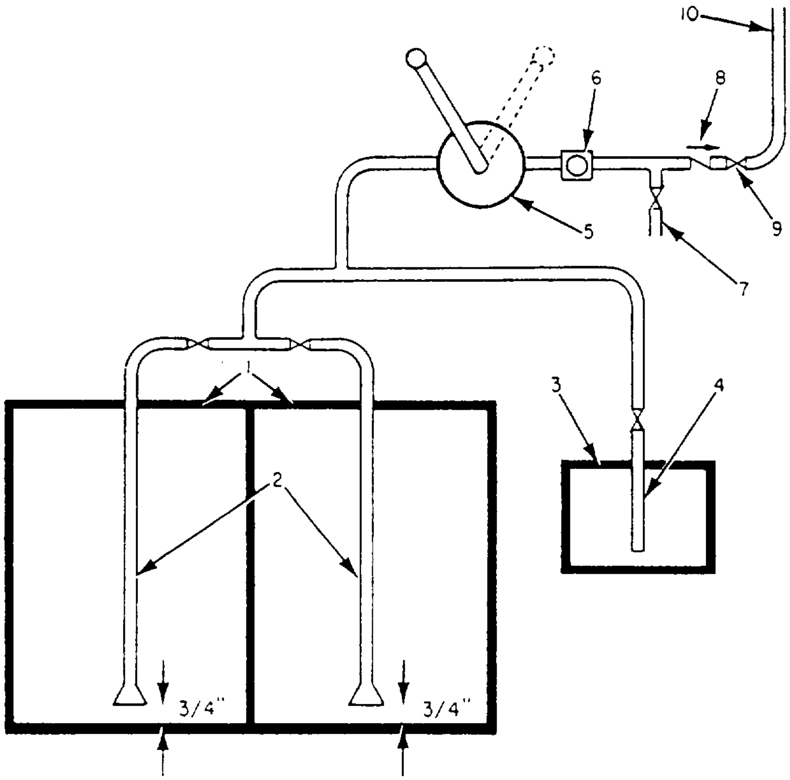
Motor-Driven Stripping System

The motor-driven stripping system (fig. 4-3) con-sists of two low-capacity pumps, manifolds, and



1. Stripping suction main (storage tanks)
2. Stripping suction main to other storage tank nests
3. Stripping tailpipe (service tanks)
4. Stripping-pump suction header
5. Stripping-pump inlet line
6. Stripping-pump discharge line
7. Stripping-pump discharge header
8. Stripping-pump discharge to transfer main
9. Stripping-pump discharge to overboard
10. Stripping-pump discharge to contaminated-JP-5 settling tank
11. Test connection
12. Single-valved manifold
13. Flood and drain manifold
14. Storage-tank stripping tailpipes

Figure 4-3.—Typical motor-driven stripping system.



1. **Service tanks**
2. **Service-tank stripping tailpipe**
3. **Purifier drain tank**
4. **Drain tank tailpipe**
5. **Hand pump**
6. **Sight glass**
7. **Sample connection**
8. **One-way check valve**
9. **Shutoff valve**
10. **Pump discharge to contaminated-JP-5 settling tank**

Figure 4-4.-Typical hand-operated stripping system.

associated piping and valves. It is designed to perform the following functions:

1. Remove settled water and solids from the bottom of the JP-5 storage tanks (during normal stripping operations).

2. Remove the last 24 inches of usable fuel remaining in the storage tanks after the transfer pumps lose suction (when consolidating fuel or before ballasting a storage tank).

3. Remove the remaining seawater left in the storage tanks by the main drainage eductors (after tank cleaning operations or deballasting a storage tank).

4. Remove the remaining 24 inches of JP-5 from the service tanks (before cleaning or for off-loading).

5. Remove the wash water from the JP-5 service tanks (after a cleaning operation).

6. Remove water from the purifier sump tank.

The storage-tank stripping tailpipe extends from 1 1/2 inches off the tank bottom and runs to the single-valved stripping manifold.

There are two types of manifolds installed in this stripping system. One is a single-valved stripping manifold used with all JP-5 storage tanks. The other is a flood and drain manifold that is installed only in the piping to those JP-5 storage tanks that are designated to be ballasted. Flood and drain manifolds are located in the stripping system between the single-valved manifolds (for all tanks designated to be ballasted) and the stripping pumps.

The stripping mains interconnect the manifold for all the storage tanks in the group with the common suction header of the stripping pumps. There are normally two stripping mains one port and one starboard. On ships equipped with deep centerlines, double-bottoms, and peak tanks, additional lines are required to strip these tanks.

The service-tank stripping tailpipe extends from 1 1/2 inches off the tank bottom and is connected directly to the suction header of the motor-driven stripping pumps. These lines are fitted with a cutout valve, and a one-way check valve or spectacle flange.

The pump piping is arranged to take suction from the common suction header and discharge into the common discharge header. The two cutout valves in the suction header permit both pumps to take suction from either the port or starboard tanks independently, or from both sides simultaneously. The pump inlet piping contains an inlet valve, a compound gage, and on some ships, a 40-mesh basket-type strainer. The discharge piping contains a valved sample connection, pressure gage, a discharge valve, and a one-way check valve. From the discharge header, the stripped liquid can be directed to the contaminated-JP-5 settling tanks, or it can be directed to the transfer main when consolidating the fuel load.

Hand-Operated Stripping System

The hand-operated stripping system (fig. 4-4) is provided specifically for JP-5 service tanks. Its purpose is to remove water and solids from the bottom of the tanks.

The hand-operated stripping system tailpipe extends from 3/4 inch off the service tank bottom and is connected to a tanktop cutout valve. The lines from each service tank in the pump room are combined and connect directly to the suction side of the hand-operated stripping pump. The discharge line contains a sight glass, sample connection, one-way check valve, and discharge cutout valve. The stripping line discharges into the contaminated-JP-5 settling tank or purifier sump tank.

SERVICE SYSTEM

The service system (fig, 4-5) contains all the piping, valves, and related equipment necessary to deliver clean, clear, and bright JP-5 from the service tanks on the eighth deck to aircraft on the flight and hangar decks.

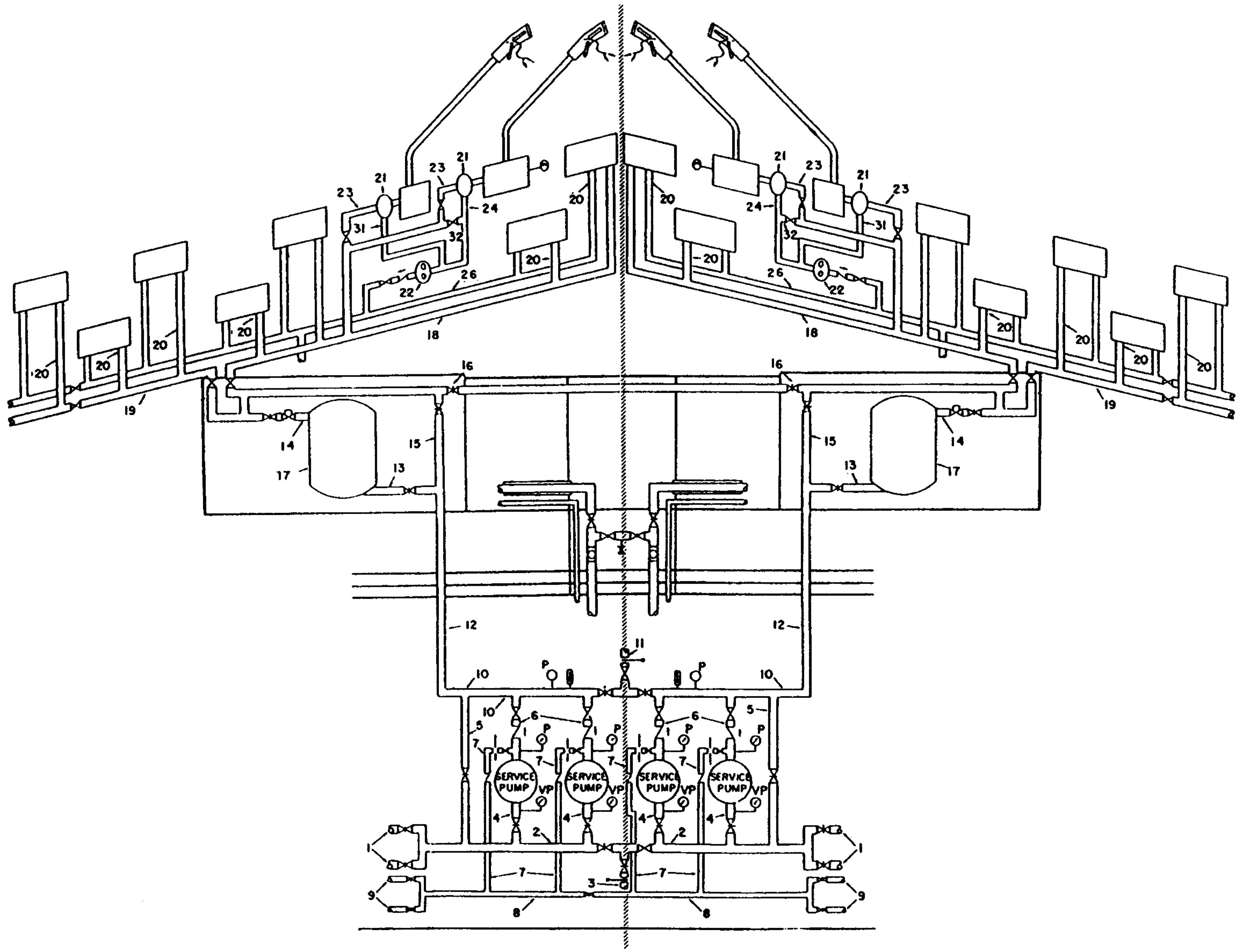
With the ability to isolate the service system into four separate quadrants, the general arrangement of this system is nearly identical on all earners. But the actual piping, valves, and related equipment will definitely vary. The service system described here is the forward section of a typical CV.

The service system piping in the pump room (fig. 4-6), begins with the service-tank suction tailpipes. These lines extend from 24 inches off the tank bottom to the service-pump common suction header. Each line is fitted with a shutoff valve to isolate the tank from the system when not in use.

The service pump common suction header is divided into a port and starboard suction header by a set of crossover valves. During normal operations, these crossover valves are open to allow the use of any service pump with any service tank. Additionally, the cross-connections from the transfer pump suction header, fitted with a spectacle flange or line blind valve, and a cutout valve interconnect with the service pump suction header between these valves. This arrangement allows two service pumps to be used as transfer pumps, and two for servicing aircraft. Of course, this would bean emergency arrangement if all three transfer pumps were disabled. Otherwise, the cross-connection is only opened to allow service pumps to be used for off-loading JP-5.

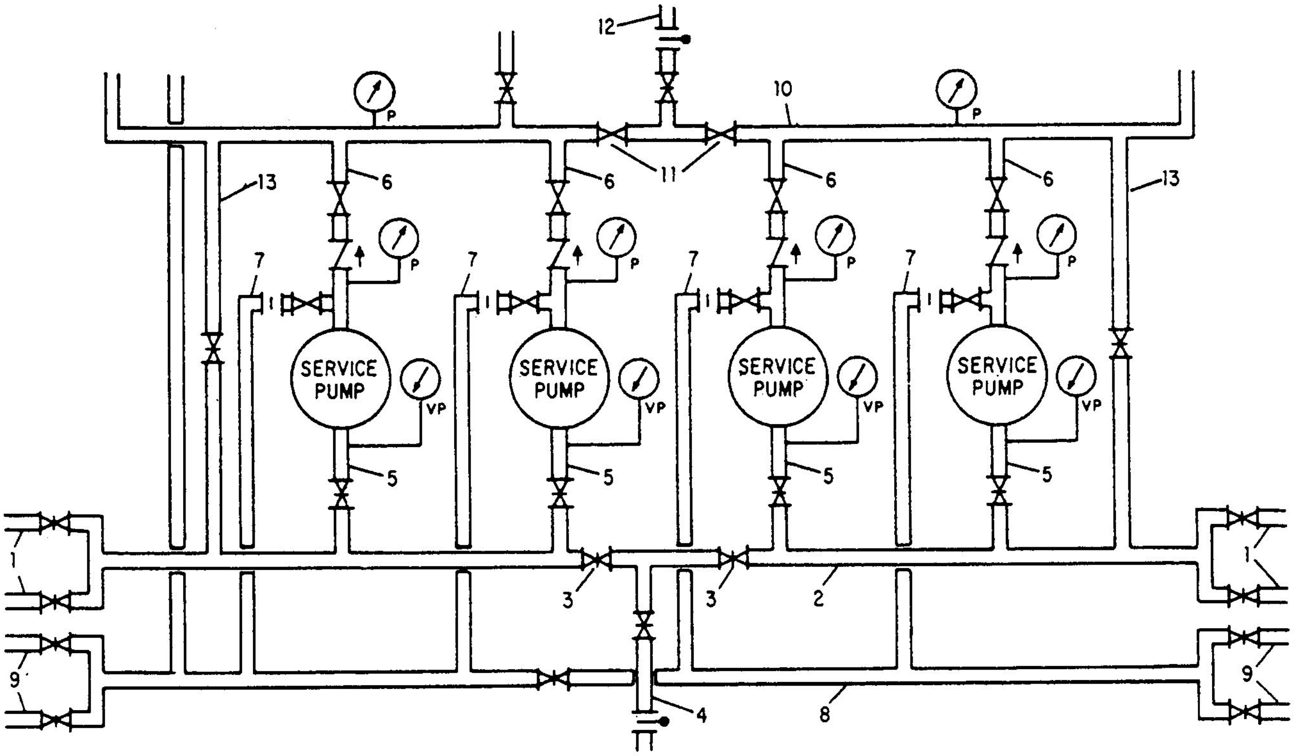
The service pumps are connected to the suction header by the pump inlet. This line contains an inlet valve and a compound gage. The discharge line, connecting the pumps to the common discharge header, contains a recirculating line, pressure gage. one-way check valve, and a discharge valve.

The recirculating line has an orifice to recirculate about 5% of the rated capacity of the pump back to the service tank from which suction is being taken. The recirculated fuel through the pump casing keeps the pump cool during standby condition. This is when the system is pressurized (pumps are running), but no fuel is being drawn topside. The recirculating lines (one for each service pump), terminate in a recirculating header. The header in turn is connected to each service tank recirculating line. These lines, fitted with shutoff valves, terminate 18 inches horizontally off the tank bottom. A number of 1-inch holes, equally spaced along the top of the recirculating line allow JP-5 to be returned to the tank without disturbing the contents of the tank. When the system is being set up for operation, the recirculating header MUST be aligned to the service tank from which suction will be taken. Also, when the service tank is changed, so must the recirculating header.



1. Service-tank suction tailpipe
2. Service-pump common suction header
3. Cross-connection to transfer-pump suction header
4. Service-pump inlet line
5. Service-pump bypass line
6. Service-pump discharge line
7. Service-pump recirculating line
8. Recirculating header
9. Service-tanks recirculating lines
10 Service-pump common discharge header
11. Cross-connection to transfer-pump discharge header
12. Quadrant distribution line
13. Filter inlet
14. Filter discharge15. Filter bypass
16. Port and starboard filter cross-connection
17. Filter
18. Forward-quadrant distribution main
19. After-quadrant distribution riser
20. Service station risers
21. Cla-Val fuel/defuel valve
22. Defuel pump
23. Cla-Val inlet lines
24. Defuel line
25. Defuel recirculating line
26. Defuel main

Figure 4-5.—Typical service system.



1. Service-tank suction tailpipes
2. Suction header
3. Suction-header cross-over valves
4. Cross-connection to transfer-pumps suction header
5. Pump inlet
6. Pump discharge
7. Service-pump recirculating line
8. Recirculating header
9. Service-tank recirculating lines
10. Discharge header
11. Discharge-header cross-over valves
12. Cross-connection to transfer pump discharge header
13. Pump bypass lines

Figure 4-6.—Typical service system pump-room piping arrangement.

The service pump discharge header is common to all four service pumps. Like the suction header, it is divided into port and starboard headers by a set of crossover valves. The cross-connection to the transfer pump discharge header is used with, and for the same purpose as, the cross-connection between the respective suction headers of the transfer and service pumps. They are also used to drain back the service piping for maintenance.

From the service pump common discharge header (on the seventh deck), the distribution riser extends directly to the filter room (on the third deck). JP-5 enters the service filter through the inlet section and leaves the filter through the discharge line attached to the clearwell chamber and the automatic shutoff valve. Both inlet and discharge have shutoff valves.

The filters are also provided with a bypass line. This line fitted with a shutoff valve (locked closed), is installed between the filter inlet and discharge lines. The bypass line is primarily used for draining back the distribution piping for maintenance.

As the distribution piping leaves the discharge side of the service filter, it is divided into two sections (commonly called “legs”). Each leg extends outboard; one goes forward to supply all the service stations in the forward section of the quadrant, and the other goes aft to supply all the service stations in the aft section of the quadrant. This piping may or may not run outside the skin of the ship and is known as the outboard distribution main.

The aft leg of the forward quadrant and the forward leg of the aft quadrant are connected by a set of cross-over valves. Additionally, port and starboard quadrants are connected by cross-over valves. With the correct alignment, this allows fuel to be pumped from any service pump in either pump room to any service station on the flight or hangar decks.

Service station risers extend upward from the outboard distribution main to supply the service stations on the hangar and flight decks. At the service station, the supply riser branches off to each hose reel.

Isolation valves are installed at strategic points throughout the outboard distribution piping. These valves are normally in the open position during at-sea operations, but are closed to isolate specific sections in an emergency or if damage occurs. They are located in both the outboard distribution main and the service station risers.

Jet Test System

This system provides JP-5 to the Jet Engine Test Facility located on the fantail of aircraft carriers. The system has its own pump and filter/separator. Supply to this system is from the JP-5 service-pump suction header. The system has a return line from the test stand to permit operation of jet engines at various flow rates.

Auxiliary JP-5 System

This system provides JP-5 to emergency diesel generators, auxiliary boilers, small-boat filling stations, or combat vehicle/support equipment filling station. It is an independent system and typically consists of an auxiliary pump, an auxiliary main and branches supplying each station. This system is also supplied from the JP-5 service-pump suction header.

JP-5 FUELING SYSTEM COMPONENTS

LEARNING OBJECTIVE: Identify the various components that make up the JP-5 below decks fueling system. Describe their function, principles of operation, and operating limits.

In the first section of this chapter, we talked about JP-5 fueling subsystems. We discussed their typical arrangements and where pumps, filters, cutout valves, purifiers, and other components would fit in that system. And as was stated earlier, though all JP-5 fueling system arrangements are alike the actual makeup of each system will be different.

In this section, we identify and describe specific components of the JP-5 fueling system. We cover their description, operating capacities, some troubleshooting and maintenance, and where they would typically fit in a subsystem. Remember, your individual systems may vary.

PUMPS

A pump is a machine that draws a fluid into itself through a suction port and forces the fluid out through a discharge port. The ABF uses pumps in the JP-5 below decks system to move JP-5 from tank to tank, and to lift JP-5 to the flight and hangar deck refueling stations.

Wear occurs in a pump as in any other piece of machinery. To maintain a pump at or near the efficiency it had when new and to keep maintenance at a minimum periodic tests should be made to determine the delivery capacity of the pump. When a test indicates a noticeable reduction in the delivery capacity, it is a sign of possible internal wear. The pump should be opened for inspection in accordance with PMS. If corrective action is not immediately taken total failure of the wearing parts may result in excessive repair costs as well as considerable down time of the pump. *Always follow the manufacturer's instructions in the applicable technical manuals.* The various type pumps and their functions are discussed here.

Centrifugal

Due to their simplicity and adaptability to a wide variety of operating conditions, centrifugal pumps are widely used. They can be modified to operate over a wide range of heads, can handle liquids at all normal temperatures, and operate at speeds that are standard for motors or turbines. The characteristics of these pumps are such that liquid flow from them is continuous, and their discharge can be throttled without building up excessive pressures in the pumps or overloading the driving unit.

The most common manufacturers of the centrifugal pumps used in the JP-5 below decks system are Aurora and Carver. The Aurora is the pump discussed here. But, there are other pumps installed and you should always consult the technical manual for details on the specific pump in your system.

The primary use of centrifugal pumps in the JP-5 below decks system are as service pumps. The Aurora JP-5 Service Pump is a double-suction, single-stage, centrifugal pump. The pump is designed to deliver fuel at 1,100 gallons per minute at 150 psi with a

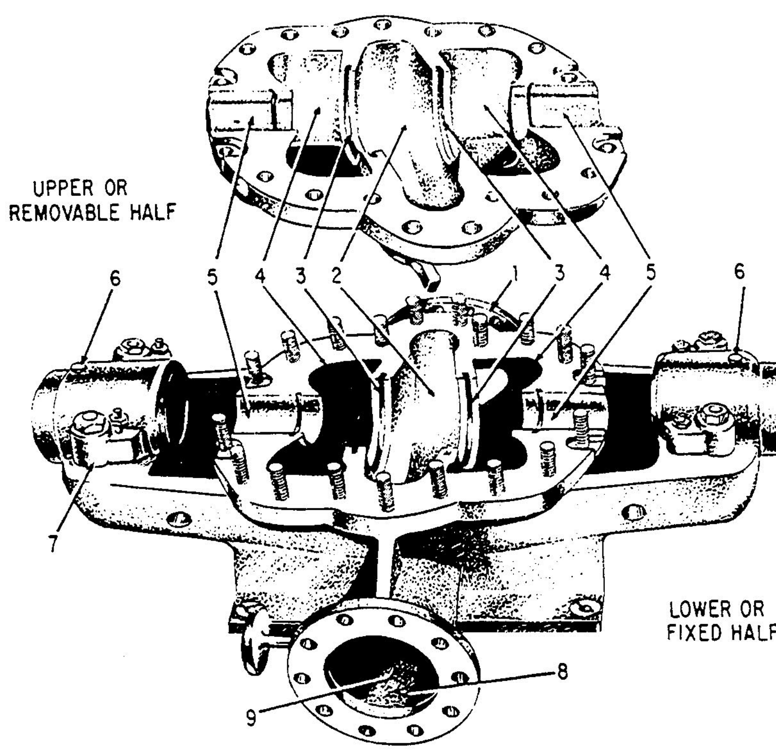
20-foot suction lift. The pump consists of a split casing, wearing rings, and rotating element.

SPLIT CASING.— The casing (fig. 4-7). is horizontally split at the shaft centerline. This enables easy removal of the upper casing half for inspection and maintenance. The casing is divided into three chambers; two suction and one discharge. The upper half of the casing contains a flange that may connect the pump to an air eliminator valve. Two external seal lines on the upper casing feed fuel from the discharge chamber to cool the mechanical seals. The lower half of the casing contains bearing housings, a suction flange and a discharge flange that connect the pump to the piping system. Drain holes and drain plugs are provided at the bottom of both flanges for draining the pump.

WEARING RINGS.—There are four replaceable type wearing rings (two rotating and two stationary) installed within the pump casing. The two rotating are installed on the impeller. The two stationary are installed in the pump casing between the suction and discharge chambers. The stationary rings are held in place and prevented from rotation by the tongue-and-groove construction. When the pump is assembled, the rotating wearing rings ride inside the stationary rings. (Check the appropriate technical manual for the correct clearance between the stationary and rotating rings.)

Wearing rings serve two purposes: (1) owing to their unique construction and close tolerances, they minimize leakage between the discharge and suction chambers and (2) they allow for the wear created between the impeller and pump casing.

Fuel passing through the pump has a tendency to recirculate from the discharge chamber back to the suction chamber. As the fuel passes through the narrow clearance between the wearing rings, a partial seal is made by the rapid rotation of the impeller. This seal minimizes the leakage between the discharge and suction chambers. After prolonged use of the pump, the clearance between the wearing rings gradually increases due to wear. This is caused by the friction created by the rapid rotation of the impeller and the fuel passing between the wearing rings. As the clearance increases, the sealing effect decreases resulting in the loss of the rated capacity of the pump.



1. **Pump inlet (suction)**
2. **Impeller housing and discharge chamber**
3. **Housing for stationary wearing rings**
4. **Suction chamber**
5. **Stuffing box**
6. **Bearing caps**
7. **Bearing housing**
8. **Discharge outlet**
9. **Drain hole**

Figure 4-7.—Centrifugal pump casing.

ROTATING ELEMENT. —The rotating element (fig. 4-8) consists of an impeller and pump shaft, shaft sleeves and nuts, ball bearings, mechanical seals, and a flexible coupling.

Impeller and Pump Shaft. —The impeller is a double-suction, closed impeller. It is keyed to, and rotates with, the pump shaft. The impeller is centered in the discharge compartment of the pump casing and prevented from axial movement by two shaft sleeves and two shaft nuts. The two shaft sleeves actually act as long spacers between the impeller and shaft sleeve nuts. The shaft sleeves are also keyed to, and rotate with the pump shaft. Fuel enters the center part of the impeller from both sides of the suction chamber and is pumped into the discharge chamber. The impeller blades are enclosed by side plates. The blades are designed to curve backward in relation to the rotation of the impeller to increase pump efficiency, and impart velocity to the fuel in the casing. Mechanical seals (fig. 4-9) fitted on the pump shaft guard against fuel leakage from the pump and prevent air from entering the casing around the shaft. The seals are installed in the stuffing boxes provided on each side of the pump casing.

There are two types of mechanical seals, the John Crane, and Durametalic. The principle parts of the John Crane mechanical seal are the stationary floating seat, low friction sealing washer, and spring. It is a single piece unit.

The principle parts of the Durametalic mechanical seal are the stationary insert, seal ring, compression ring and collar assembly, and the shaft packing. It is a three piece unit.

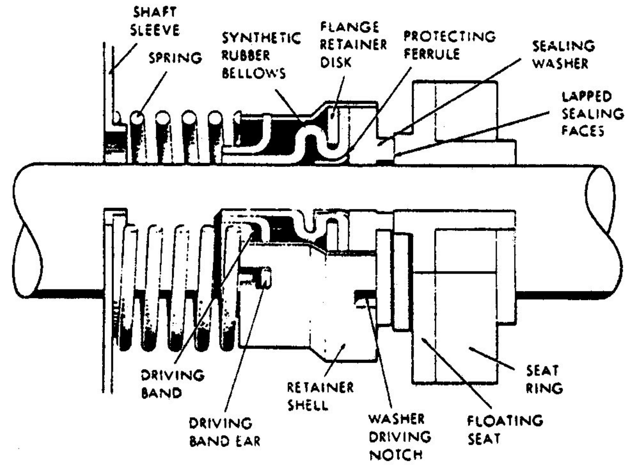


Figure 4-9.—John Crane mechanical seal.

NOTE

Some parts of mechanical seals are made of carbon and break easily. Handle mechanical seals carefully.

Bearing Cartridges. —Both ends of the pump shaft extend outside the upper half of the casing. Pump shaft ends are supported by ball bearings encased in bearing cartridges and cradled in the bearing brackets of the lower casing half. The ball bearings absorb radial and axial thrust, and ensure free rotation of the pump shaft. A single ball bearing is housed in the inboard bearing cartridge, allowing the inboard bearing some axial movement within the cartridge. Duel ball bearings are housed in the outboard bearing cartridge. The ball bearings are slipped on and held firmly against a shoulder on the pump shaft by a lock washer and locknut. The ends of the bearing cartridges that lie closer to the center

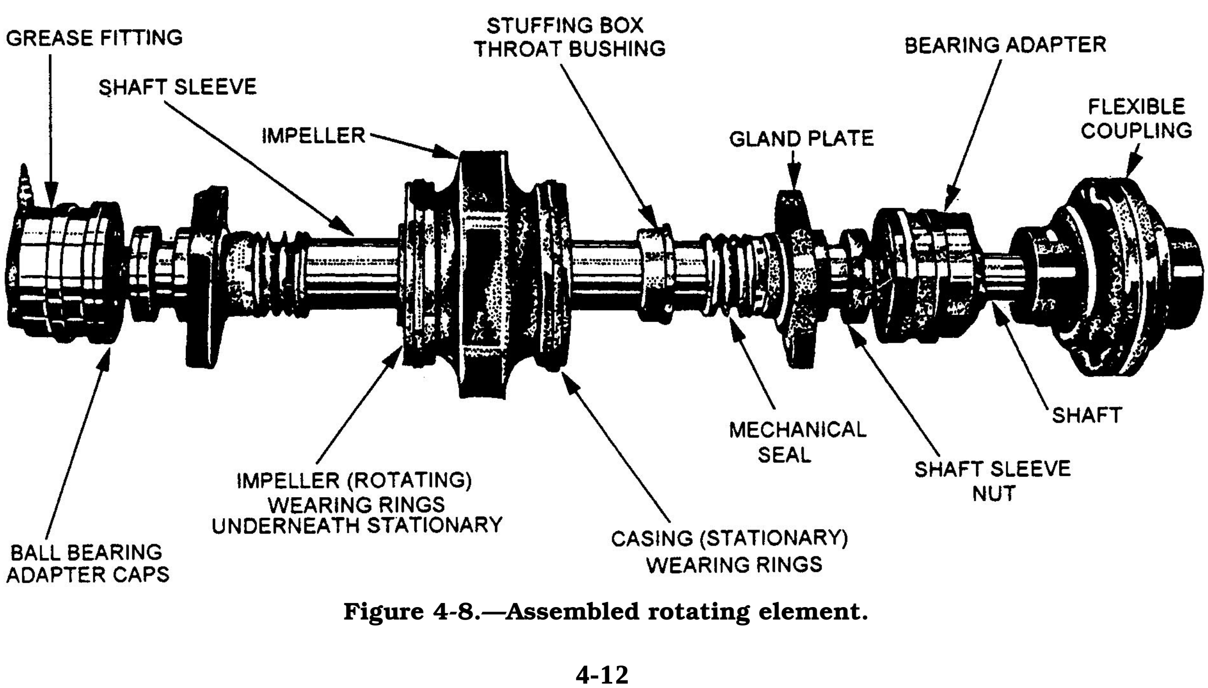


Figure 4-8.—Assembled rotating element.

of the pump are enclosed by bearing covers. The bearing covers prevent bearing grease from leaking out of the bearing cartridges. In addition, the bearing covers prevent dirt and water, or fuel from entering the bearing cartridges. The outside ends of the bearing cartridges are enclosed by bearing caps. A grease cup and a grease fitting are installed on both of the bearing caps to allow addition of grease to the bearings. Grease reliefs are also installed to release grease during heat expansion.

Flexible Coupling. —The flexible coupling is designed to allow for misalignment between the motor shaft and the pump shaft. The coupling hubs are keyed to both the pump and motor shafts and are lubricated to reduce wear in the coupling.

THEORY OF OPERATION. —The spinning impeller causes fuel to leave the discharge chamber of the pump. This creates a suction that causes a continuous flow of fuel to the pump. Fuel from the service tank simultaneously replenishes the fuel that leaves the suction chamber **as long as the pump has a positive suction head.** Centrifugal pumps WILL NOT draw a vacuum. Fuel in the suction chamber enters the center part of the impeller. The blades of the impeller propel the fuel toward the discharge chamber walls by centrifugal force. The expanding spiral shape of the discharge chamber slows the fuel which increases the pressure and creates a continuous flow through the pump. Flow is continuous as long as there is enough fuel at the suction side, air does not enter the pump, fuel discharge is not restricted, and the impeller rotates at the rated speed.

MAINTENANCE. —Maintenance on the JP-5 centrifugal service pump is done in accordance with PMS and the applicable technical manuals. Typical maintenance is discussed in the following paragraphs.

LUBRICATION. —The importance of proper lubrication of the ball bearings cannot be over-emphasized. But, it is possible to over-grease the bearings, which causes overheating and damage to the bearings. Additionally, the wearing rings and mechanical seals require JP-5 for lubrication. Running the pump dry will damage these parts.

WEARING RINGS. —Wearing rings should be inspected when the pump does not discharge at the rated capacity. They are replaced when the radial clearance stated in the pump's technical manual is reached.

MECHANICAL SEALS. —Mechanical seals require no maintenance, but should be replaced whenever leakage occurs, or when the sealing surfaces have been disturbed.

TROUBLESHOOTING. —Table 4-2 lists typical malfunctions, probable causes, and corrective action for the JP-5 service pump.

Rotary Vane

Blackmer is the most commonly used rotary vane pump in the JP-5 below decks system. These pumps come in different sizes with different operating capacities and are used as transfer pumps, auxiliary pumps, stripping pumps, and on the flight deck as defuel pumps. Each pump may vary slightly, but all are practically identical.

The Blackmer (fig. 4-10) is a positive displacement, rotary vane type pump. The pumps used for stripping are designed to pump 50 gpm at 50 psi. The pumps used

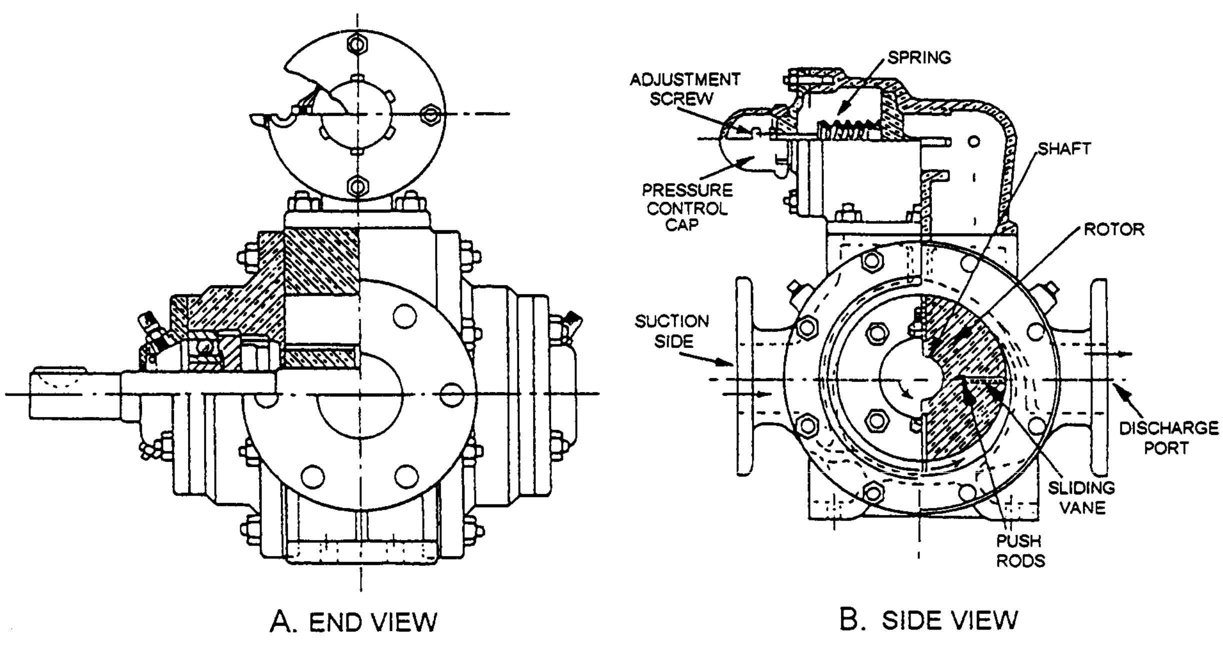


Figure 4-10.—Blackmer rotary vane pump: A. (End view); B. (Side view).

Table 4-2.—JP-5 Service-Pump Troubleshooting Guide

MALFUNCTION	PROBABLE CAUSE	CORRECTIVE ACTION
No fuel discharge from pump.	Impeller or suction line clogged.	Backflush pump to clear obstruction. Disassemble pump or suction line and remove obstruction.
Pump fuel discharge at reduced capacity or pressure.	Impeller or suction line partially clogged.	Backflush pump to clear obstruction. Disassemble pump or suction line to remove obstruction.
	Air leakage in mechanical seals.	Check mechanical seals. Replace defective mechanical seals.
	Wearing rings worn.	Replace defective wearing rings.
	Impeller damaged.	Replace impeller.
	Casing gasket defective.	Replace defective casing gasket.
Pump starts then stops fuel discharge.	Air leakage in mechanical seals.	Check mechanical seals. Replace defective mechanical seals.
Pump binding.	Impeller clogged.	Backflush pump to remove obstruction. Disassemble pump. Remove obstruction from impeller.
	Wearing rings worn or damaged.	Check wearing rings. Replace defective wearing rings.
	Impeller damaged.	Replace defective impeller.
	Pump and motor shafts misaligned.	Check pump and motor shaft alignment and alaign shafts.
	Pump shaft bent or warped.	Replace pump shaft.
	Bearings worn.	Check bearings. Replace defective bearings.
Pump noisy or vibrates excessively.	Pump bearings or motor bearings are worn.	Check defective pump or motor bearings. Replace pump or motor bearings.
	Impeller binding or obstructed.	Backflush pump to remove obstruction. Disassemble pump. Remove obstruction from impeller. Replace impeller.
	Pump and motor shafts misaligned.	Check pump and motor shaft alignment and align shafts.
	Pump shaft bent or warped.	Replace pump shaft.
	Mounting bolts loose or broken.	Tighten or replace mounting bolts.

for transfer are designed to pump 200 gpm at 50 psi. The typical rotary vane pump consists of a cylinder and head assembly, rotor and shaft assembly, and a pressure control valve.

CYLINDER AND HEAD ASSEMBLY. —The cylinder (pump casing) houses and provides a working area for the rotor and shaft assembly. The cylinder is machined to form an egg-shaped cylinder bore. The inlet and discharge ports are cast integrally with this section of the pump. The pressure control valve, located on the top of the pump, is cast integrally with the upper portion of the cylinder bore. Each side of the cylinder has machined recesses to ensure perfect fit of the cylinder heads.

The cylinder heads (fig. 4-1 1), one for each side of the pump, house the ball bearings and mechanical seals. An O-ring is installed between the cylinder heads and the cylinder to prevent leakage.

The ball bearings, located in the bearing housing within each cylinder head, support and ensure free rotation of the rotor and shaft assembly, and maintain the proper clearance between the rotor and upper position of the cylinder bore. A bearing cover, with a grease fitting at the top and a grease relief fitting at the bottom, is bolted to the end of each cylinder head.

The mechanical seal installed in each head prevents leakage of fluid along the shaft into the bearing housing. A telltale drain hole, located directly under the bearing housing, is provided on the underside of each head. These holes are intended to serve as an indication of leakage by the mechanical seal.

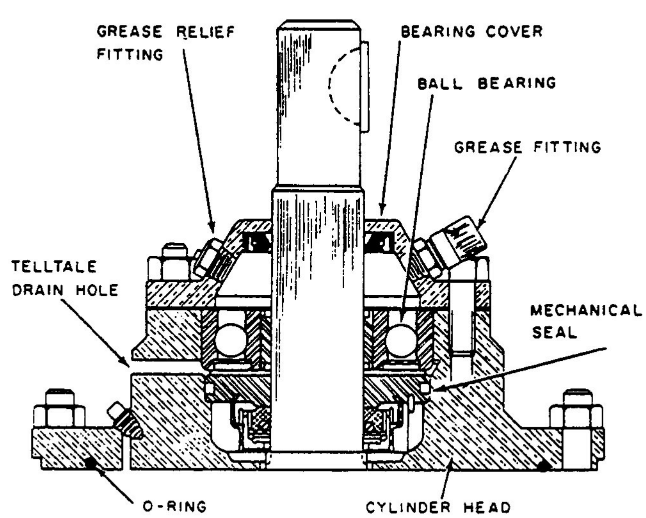


Figure 4-11.—Rotary vane pump cylinder head.

ROTOR AND SHAFT ASSEMBLY. —The rotor and shaft is a pressed fit assembly held in place by tapered pins. The rotor is centered in the upper portion of the oval shaped cylinder bore. The rotor has an even number of equally spaced slots that provide the working area for the sliding vanes. Holes are drilled through the rotor and shaft, one between each set of opposing slots, for the installation and working area of the push rods.

The sliding vanes are made of palamite. Relief grooves are provided on the forward face of the vanes to allow the escape of liquid trapped between the vanes and the slots in the rotor.

NOTE

The vanes must face the direction of rotation to allow the escape of fluids into the discharge port.

The pump shaft connects to a gear reducer shaft by a flexible coupling. The opposite shaft of the gear reducer is connected to the shaft of the drive motor, also by a flexible coupling. The purpose of the gear reducer is to mechanically reduce the motor rpm to match the rated rpm of the pump.

PRESSURE CONTROL VALVE. —The pressure control valve is provided to prevent buildup of excessive pressure that might damage the pump or associated equipment. When over-pressurization occurs, the valve directs fluid from the discharge side to the suction side of the pump. It is spring-loaded closed. An adjustment screw adjusts spring tension on the valve disc. Relief pressure is determined based on pump application and piping design. The adjustment screw has a locknut to lock it at the set pressure. The pressure control cap is screwed on the cover to protect the adjustment screw threads.

THEORY OF OPERATION. —The rapid rotation of the shaft and rotor forces the vanes in sliding contact with the cylinder bore by centrifugal force and by push rods. The passage of the vanes through the lower portion of the cylinder bore draws fluid into the pump, and at the same time, forces it out the discharge port. Rotary vane pumps are positive displacement pumps. This means they will pump air, which creates a vacuum, causing liquid to be pulled into the suction side of the pump.

MAINTENANCE. —Maintenance on the rotary vane pump is done in accordance with PMS and the applicable technical manuals. Typical maintenance includes the following:

LUBRICATION. As stated previously, proper lubrication is a MUST. But do not over-grease. After lubrication, a small amount of grease may escape from the grease reliefs under the head. This is normal. But, if grease continues to escape the grease relief fitting should be removed and inspected for damage, or the bearing removed and its grease shield inspected for damage. If grease escapes from around the pump shaft, the bearing cover should be removed and the lip on the shaft seal inspected for nicks, cuts, or distortion. Replace if necessary.

MECHANICAL SEALS. No maintenance required. Replace if leakage occurs.

HEAD O-RINGS. If leakage occurs between the head and the cylinder, the head should be removed and both machined faces inspected for burrs, a cut or damaged O-ring, or other imperfections. If the O-ring is damaged in ANY way, replace it.

VANES. If the vanes are excessively worn, swollen, or jamming in the rotor slots, replace them.

PRESSURE CONTROL VALVE ADJUSTMENT. Line up the suction side of the pump to a storage tank, opening the required valves. Make sure the pump discharge valve is closed. Start the pump, remove the protective cap, and loosen the locknut. Turn the adjustment screw until the desired pressure is indicated on the discharge pressure gage. Tighten the locknut, replace the protective cap, stop the pump, and secure the suction side piping.

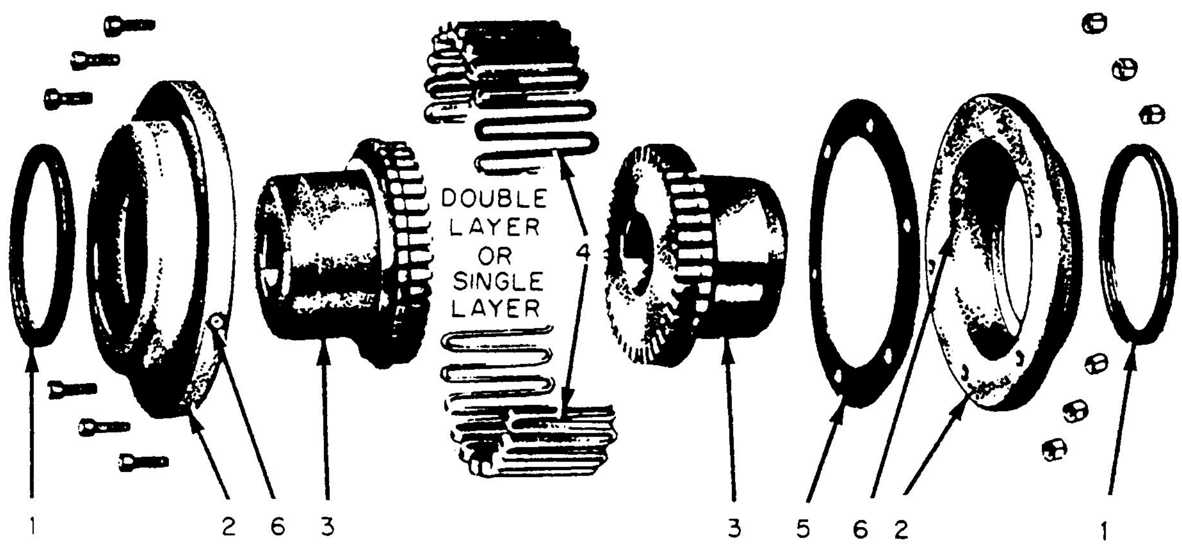
TROUBLESHOOTING. —Table 4-3 lists typical malfunctions, probable causes, and corrective action for rotary vane pumps.

PUMP COUPLINGS

All aviation fuel pumps are equipped with a type of flexible coupling. This coupling allows connection of the pump and motor (or gear reducer) shafts with a minute amount of misalignment. The flexibility of the

Table 4-3.—Rotary Vane Pump Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	REMEDY
Pump does not deliver or delivers below rated capacity.	Worn vanes. Worn heads or discs. Leaking through P/C valve.	Replace all vanes. Replace heads. a. Lap in valve seat. b. Foreign matter under valve seat. Remove. c. Valve worn out. Replace. d. Spring setting too low to hold valve shut at desired pressure. e. Valve seat worn out; replace cylinder or casing.
	Worn rotor ends. Defective bearing.	Replace rotor. Replace ball bearings.
Evidences of excessive leakage at tell-tale drain holes in heads.	Defective mechanical seal at end evidencing leak.	Replace seals as required.
Excessive grease leakage around pump shaft.	Defective grease seal.	Replace seals as necessary.



1. Seal rings
2. Cover halves
3. Hubs
4. Gridmembers
5. Gasket
6. Alemite grease fittings

Figure 4-12.—Falk Type-F Steelflex coupling.

coupling is normally gained from a gear, a spring arrangement, or a rubber insert between the coupling halves. Depending on the type of coupling, lubrication may or may not be required.

Falk Type-F Steelflex Coupling

This coupling (fig. 4-12) is a flexible, self-aligning, gridmember coupling. The two hubs are symmetrical, but may have different bores or keyways. One hub is keyed to the motor shaft, and the other hub is keyed to the pump shaft and secured axially by set screws. A flexible gridmember engages the teeth in the hubs to transmit power. A gasket and two seal rings are fitted to the covers to prevent grease leakage. The parts are enclosed in two cover halves that are bolted together.

When it is necessary to disconnect the coupling, remove the nuts and bolts, separate and draw back the cover halves, and remove the gridmember. To remove the gridmember, a round rod or screwdriver that conveniently fits into the open loop ends of the gridmember is required. Begin at the open end of the gridmember section and insert the rod or screwdriver into the loop ends. Use the teeth next to each loop as a fulcrum and pry the gridmember out radially in even, gradual stages. Proceed alternately from side to side lifting the gridmember about halfway out until the end of the gridmember is reached. Using the same procedure again, lift the gridmember until the teeth are cleared. This separates the coupling hubs.

Before reassembly, clean all parts thoroughly and check the coupling alignment in accordance with the pump's technical manual.

After the coupling is aligned, carefully insert the gasket between the hubs and hang it on either hub. Do not damage the gasket. Next, force as much lubricant as possible into the space between the hubs and grid-member grooves.

Insert the gridmembers. To accomplish this with a minimum amount of spreading, start the gridmember at either end and tap the rungs only part way into the grooves. After all the rungs are partially in their respective grooves, tap the gridmember all the way into place. The hub grooves on each hub are uniformly spaced and do not require matching. Again pack lubricant in the spaces between and around the gridmember, then wipe off the excess flush with the top of the gridmember. Lightly oil the hubs to ease the sliding of the covers onto the hubs. Mount the covers so the lubrication fittings are 180 degrees apart. Insert a screwdriver under the seal ring for venting purposes and then tighten the cover bolts. Remove the screw-driver, check the seal rings for proper seating, and align the cover to prevent wobble.

Lovejoy Coupling

The Lovejoy coupling (fig. 4-13) mechanically links the shaft of the pump to the shaft of the motor (or gear reducer). The coupling is made of two bronze coupling halves. The coupling is keyed to the shaft and held in place by socket-head setscrews. The coupling halves are cushioned by a formed rubber spider that separates the coupling halves. This rubber separation reduces wear on the coupling halves.

When the reassembly of any component of the pump unit involves re-coupling, the coupling should be checked for misalignment using a straightedge and feeler gage. As different pumps have different size couplings that require different clearances, consult the specific pump technical manual for proper clearance of your specific coupling. When adjusting the couplings, make sure each section of the coupling is tightly anchored to its respective shaft and that both sections are butted together with the correct space (according to the specifications in the technical manual) between the coupling sections and the rubber spider. The Lovejoy coupling requires no lubrication.

Rex Chain Coupling

The Rex chain coupling mechanically links the shaft of the pump with the gear reducers on motor driven stripping pumps. Each shaft has a toothed gear attached and, when both shafts are aligned, a chain is placed around both gears, connecting both halves. It resembles small bicycle sprockets placed side by side with a double wide chain connecting the two.

Although periodic inspection and lubrication are required, the main advantage is its ease of removal and alignment. The gears and chain are steel and can break if hit with a hammer. Therefore, do NOT use force. When installing a Rex chain coupling, if you feel force is needed, you are doing something wrong.

VALVES

Several types of valves are used in the JP-5 systems. Typically, the valves used in the filling and transfer system are of the gate type. Most discharge valves on pumps are of the globe type. Distribution piping may contain gate, globe or butterfly. Newer ships may have limitorque valve operators in their system. In the following paragraphs, we will discuss the various type valves, their description and construction, and their normal use. Know the type of valves in your system and their location.

Gate Valves

A gate valve (fig. 4-14) is used where a straight flow with a minimum amount of restriction is desired.

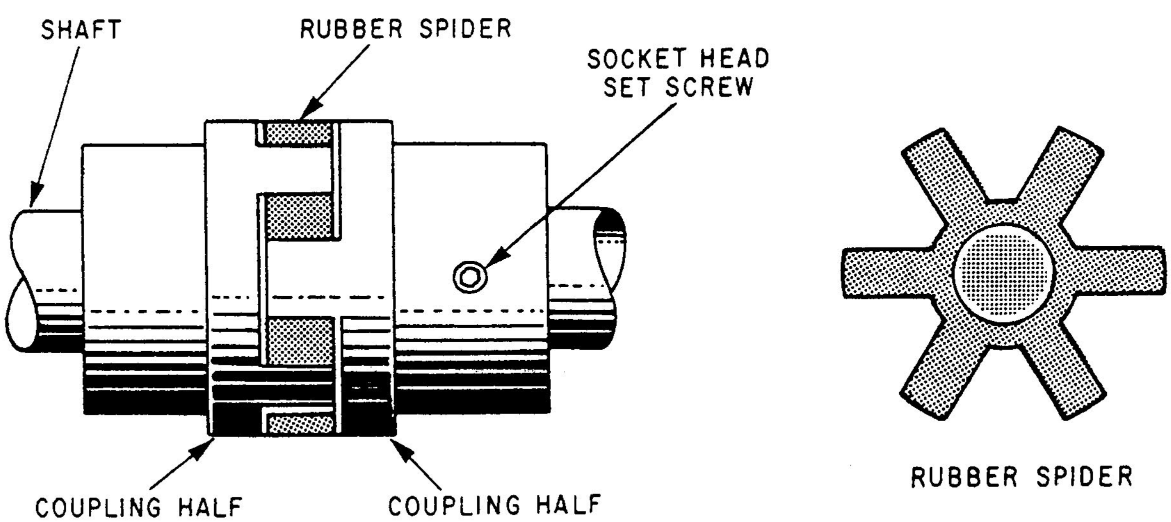


Figure 4-13.—Lovejoy coupling.

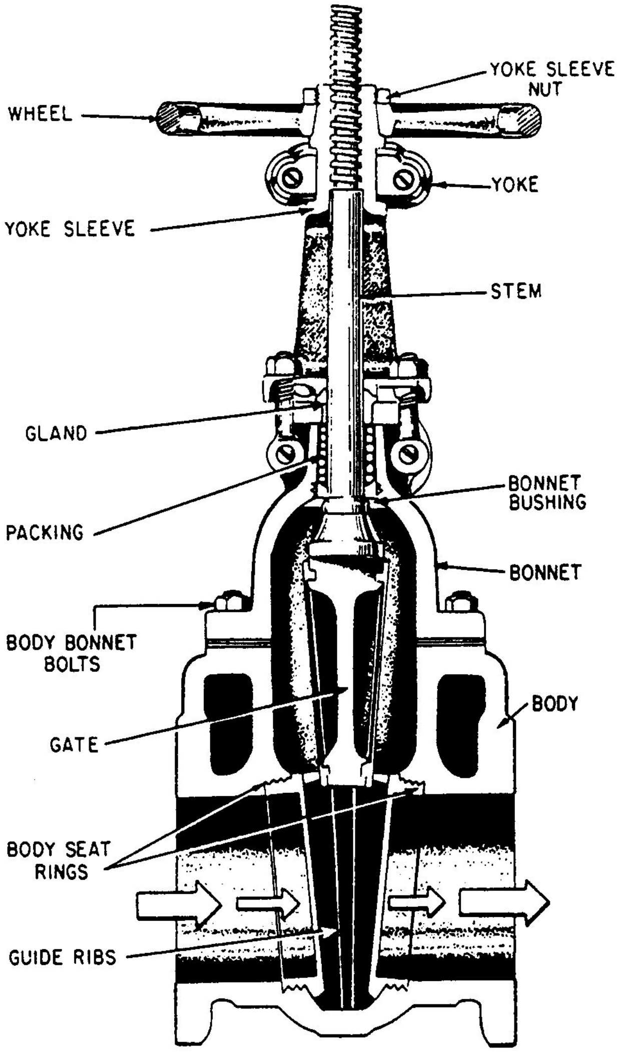


Figure 4-14.—Gate valve.

Gate valves are not designed for and cannot be used for throttling. Most gate valves have a wedge-shaped gate, but some have a gate of uniform thickness. The gate is connected to the valve stem and is positioned by rotating the handwheel. The port is the full size of the pipe and extends through the valve.

Some types of gate valves have a rising stem, and a glance at the valve will tell whether it is open or closed. In the type of valve with the nonrising stem, the stem revolves in the bonnet and the gate is raised or lowered by the threads on the internal end of the stem. On this type of valve, a pointer is usually in-stalled to indicate the open or closed positions.

Gate valves operate properly with either face on the inlet side, thus simplifying installation. Case or forged steel valves have disks and seats made of nickel-copper alloy, chromium steel, or a steel treated with a hard facing material. Valve stems are made of corrosion resistant steel. Handwheels are made of fabricated steel, brass, or aluminum. Except for malleable iron or aluminum handwheels, bronze gate valves are made entirely of bronze.

NOTE

It is a good practice to put a gate valve back together the same way it came apart. Although the valve operates with either face on the inlet side, after installation and use in a specific flow pattern, one side of the valve may wear a little differently from the other. To ensure a tight fit and smooth operation, put it back the same way it came out.

Globe Valves

Globe valves (fig. 4-15) are so called because of the globular shape of their bodies. It must be noted

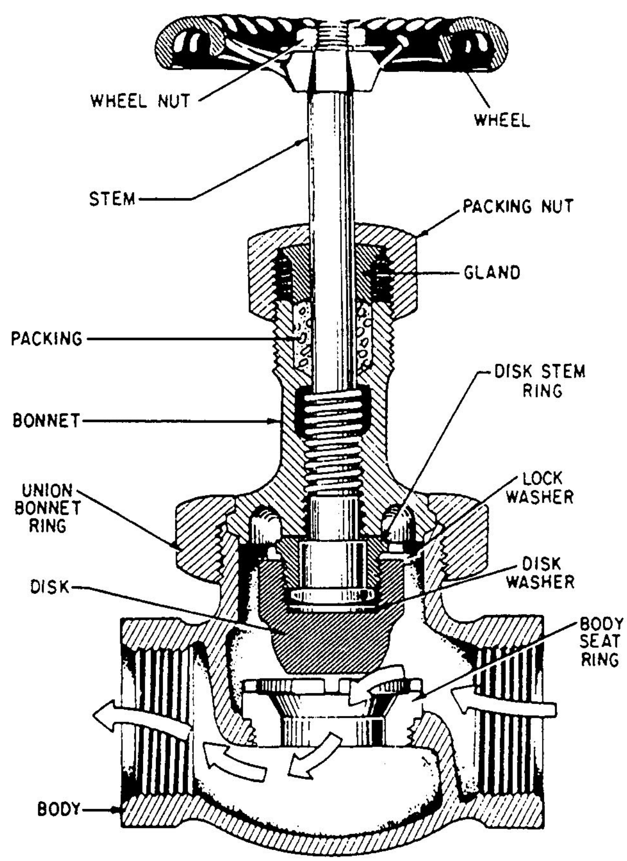


Figure 4-15. —Globe valve.

that other types of valves also may have globe shaped bodies. Therefore, the name does not always describe the valve properly.

In a globe valve, the disk is attached to the valve stem and seats against a seating ring or seating surface that shuts off the flow of fluid. When the disk is moved off its seat, fluid can pass through the valve. Globe valves may be used to limit fuel flow through the valve (called throttling) by partially opening the valve to meet the desired flow. Globe valves are most commonly found on pump discharges, tank manifolds, JP-5 purifier discharges, and any other place where there is a need for throttling fuel flow.

Globe valve inlet and outlet openings are arranged in several ways and are used to suit the requirements of the flow. There are three common types of globe valve bodies. In the straight body, the inlet and outlet openings are in line with each other. In the angle body, the inlet and outlet openings are at an angle to each other. The cross globe valve has three openings instead of two, and is frequently used in connection with bypass piping.

High Performance Butterfly Valves

The high performance butterfly valve (fig. 4-16) used in the JP-5 system is designed specifically for flammable liquids or other hazardous materials. If a fire guts a piping system or space where these valves are located, and the fire is hot enough to melt a special sealing element, a secondary metal sealing takes place providing effective shut-off of fluid flow through the piping. No feeding of the fire can take place.

The high performance butterfly valve has a single-piece flexible polymeric seat that is pressure energized to assure positive shutoff. The seat is so designed that is compensates for pressure and temperature changes as well as for wear. The design also allows no metal to metal contact during regular operations. Also contributing to the valve's effectiveness is its offset shaft and eccentric disk design that impart a camming action to the disk. This feature causes the disk to swing completely out of contact with the seat upon opening, eliminating wear points at the top and bottom of the seat.

This arrangement allows replacement of the valve seat, if it is ever required, by simply removing the body insert and then replacing the seat. You do not have to disassemble the shaft or disk. With no requirement to remove the shaft and disk, repair time is cut dramatically.

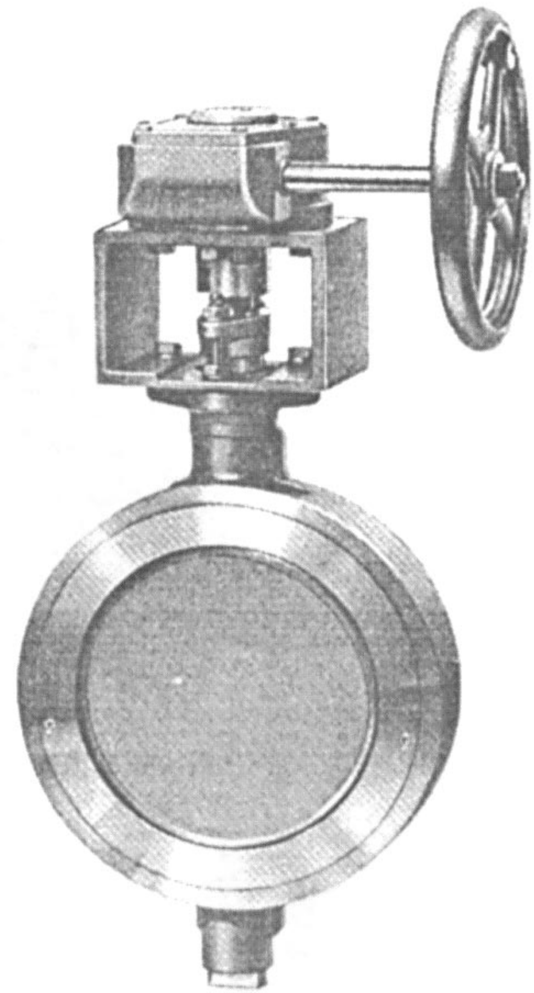


Figure 4-16.—High performance butterfly valve.

As with the gate valve, the high performance butterfly valve allows fluid flow in either direction. High performance butterfly valves are normally used as isolation valves in distribution piping, but they may be used nearly anywhere.

Limitorque Valve Operators

On newer CVNs, numerous valves have limitorque valve operators. Limitorque valve operators (fig. 4-17) open and close gate and globe valves from a remote location, usually the pump-room console (which will be discussed later in this chapter).

Each limitorque, in addition to operating a valve, also controls and limits the opening and closing travel of the valve. A torque limit switch on the limitorque protects all operating valve parts from overload by

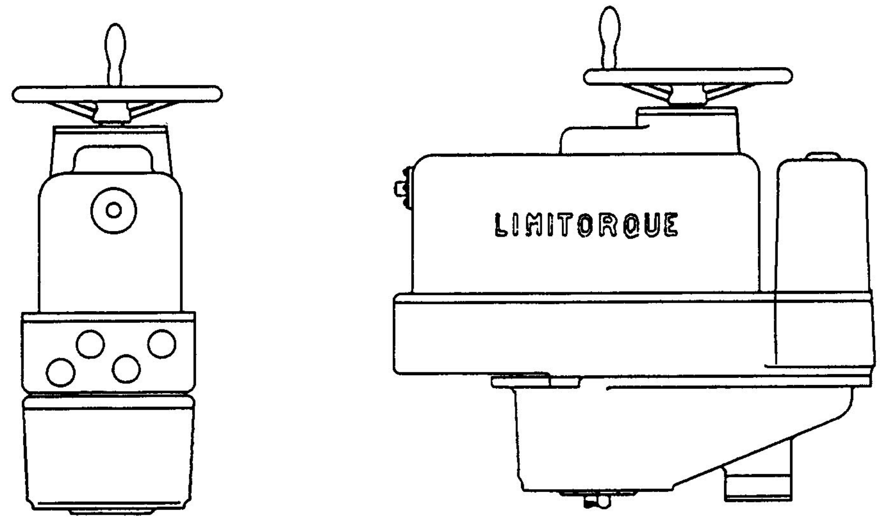


Figure 4-17.—Limitorque valve operator.

limiting the torque and thrust loads applied to the valve. It also provides a constant seating thrust, thus assuring the valve is tight on each closure. This seating thrust can be varied by a fine adjustment on the torque limit switch. The torque limit switch operates and disconnects the source of motive power should an obstruction be met while the valve is being closed.

Limit switches on the limitorque govern valve disk travel in the opening and closing directions of valve stem travel. The switches also operate position indicator lights for both the open and closed position of the valve. In case of motor failure, the limitorque unit can be operated manually by use of the handwheel. To prevent accidental operator injury, a motor declutch mechanism disengages the handwheel when the motor is energized.

Limitorque valves may be used in the following areas:

— Valves in manifolds serving JP-5 storage tanks

— Valves for filling JP-5 service tanks

— Valves taking suction from JP-5 service tanks

— Selected cut-out valves in all three sub-systems

— Selected valves in the drainage and ballast system

To the ABF, the limitorque valve operator is a valuable asset as long as it is operating and used correctly.

Swing Check (One-Way) Valves

Swing check valves (fig. 4-1 8) are designed to prevent back flow by allowing fluid transfer in only one direction in the piping systems.

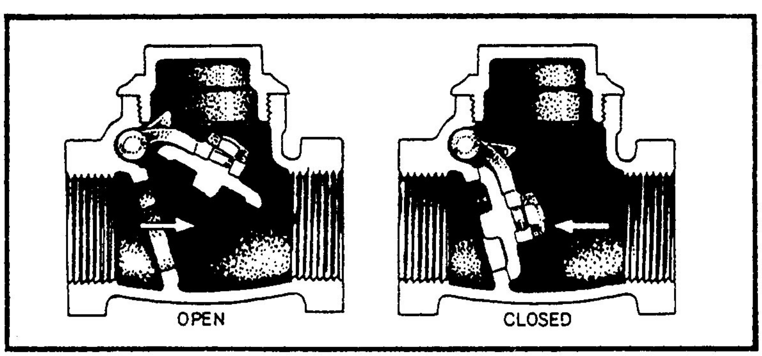


Figure 4-18.—Swing-type check valve.

Swing check valves use a disk that is attached to the valve body by a pinned hinge and is closed by gravity during a no-flow condition. This type valve is sometimes designed with a spring to assist closing the valve. Pressure caused by flow forces the hinged disk up to open the valve. But, pressure in the opposite direction will force the hinged disk back on its seat to close the valve.

The proper positioning of the valve, with reference to the horizontal, is very important to ensure proper check valve operation. Since the downward force of gravity is necessary for proper operation, a check valve installed upside down or at any angle other than horizontal may not function as intended. Also, since this valve allows flow in only one direction, it must be installed correctly. Most check valves will have a flow direction arrow on the body. If no arrow is visible, the inlet side of the valve will be the side with the hinge pin.

VALVE MAINTENANCE

All valves require proper care and maintenance, as does other more complex equipment, to ensure they are kept in optimum working order. The principle difficulties encountered with valves are leakage past the seat and disk, leakage at the stuffing box, sticking valve stems, and loose valve disks.

Losses due to leakage that is not corrected mount up considerably over time. For example, over a period of a month, a small 1/32 inch hole would waste 69.552 cubic feet of air at 100 psi, 3,175 pounds of steam at 100 psi, or 4,800 gallons of fuel at 40 psi. The ABF should know how to prevent and correct these faults.

Valve Leakage Causes and Remedies

Valve leakage, generally caused by failure of the disk and the seat to make close contact, may result from any of the following:

—Foreign substances, such as scale, dirt, or heavy grease lodged on the valve seat may prevent the disk from being properly seated. If the obstructing material cannot be blown through, the valve has to be opened and cleaned.

—Scoring of the valve seat or disk, which may be caused by erosion or by attempts to close the valve on dirt or scale, results in leakage. If the damage is minimal, the valve may be restored to proper working order by grinding. If the damage is more extensive, the valve must be reseated and then ground.

—A warped disk may result if the guides fit too tightly, if the spindle guide is bent, or if the valve stem is bent. Using a valve disk or body that is too weak for the purpose for which it is used permits distortion of the disk or seat under pressure. If this occurs, replace the valve.

Packing Gland Leakage

Packing gland leaks can be remedied by tightening the gland or repacking it. But, the gland must not be tightened nor packed so tightly that the stem binds. If the leaks persist after either or both of the remedies are applied, a bent or scored valve stem may be the cause.

Packing for the valve may be either of the string type or of the ring type. String packing is ordinarily used for small valves in low-pressure systems. Ring packing is used for large valves and for all high pressure valves. When replacing the packing on any type of valve, be sure to use the correct size and type. The packing must be large enough to fill the space between the valve stem and the packing box. It also must be made of material that is suitable for the pressure and temperature to which it will be exposed.

To pack a valve with string packing, place successive turns of packing in the space around the rod. Bevel off the ends of the packing to make a smooth fit and tighten the packing gland nut or the bonnet nut to compress the packing. String packing should always be wound in the same direction as the gland nut is to be tightened so tightening the nut does not cause the packing to fold back upon itself. To pack a valve with ring packing, cut the ends of the rings square and even so they make a level butt joint. Be sure to stagger the joints in successive rings.

In some gate, globe, and one-way check valves, the packing gland may be repacked under pressure, when necessary. These valves are constructed with the stem back-seated against the bonnet when the valve is wide open. High-pressure valves are provided with a pressure leak-off connection. The pressure leak-off connection is sealed to the outside with a pipe plug. Extreme care should be taken to see that the valve is firmly back-seated before the plug is removed. **Normally, repacking valves under pressure is NOT done by an ABF. If a valve must be repacked under pressure, ensure ALL SAFETY PRECAUTIONS are followed.**

Sticking Valve Stems

There are several of conditions that may cause valve stem troubles. If the packing is packed too tightly, or if the gland nuts are tightened unevenly, the valve stem is likely to stick or bind. Backing off on the gland nuts relieves the packing pressure. Paint or rust on the valve stem, which also causes binding, can be removed by cleaning the stem.

The valve may become stuck if the valve stem threads are burred from rough handling or upset from pressure that has been applied to move sticking and tight valves. Distorted or burred valve stem threads are very serious valve troubles. If the valve cannot be moved by any other method, the bonnet must be re-moved, the stem cut out of the yoke or bonnet, and a new stem made. If the bonnet or yoke is damaged, it also must be repaired or replaced. If burred or upset threads are detected before the stem becomes stuck, they can be dressed smooth with a file or machined in a lathe. If the sticking is due to a bent valve stem. the stem must be straightened or replaced.

MANIFOLDS

Manifolds are an integral part of the JP-5 below decks systems. They consist of several valves mounted in a compact unit, which provides a means of controlling the flow of JP-5 to and from several tanks at one central location.

Double-Valved Manifolds

Double-valved manifolds (fig. 4-19) control the flow of JP-5 to and from storage tanks that are designated storage or ballast. They give double protection against contaminating the transfer main when the storage tanks are filled with seawater by having two valves for one tanktop. These valves are known as the transfer mainside valve and the tankside valve.

The manifold HEADER is a section of pipe with several equally spaced holes in the top to accommodate the transfer mainside valves. It is sealed on both ends and has a pipe flange welded to the bottom. This pipe flange is bolted to a section of pipe leading off the transfer-main branch header.

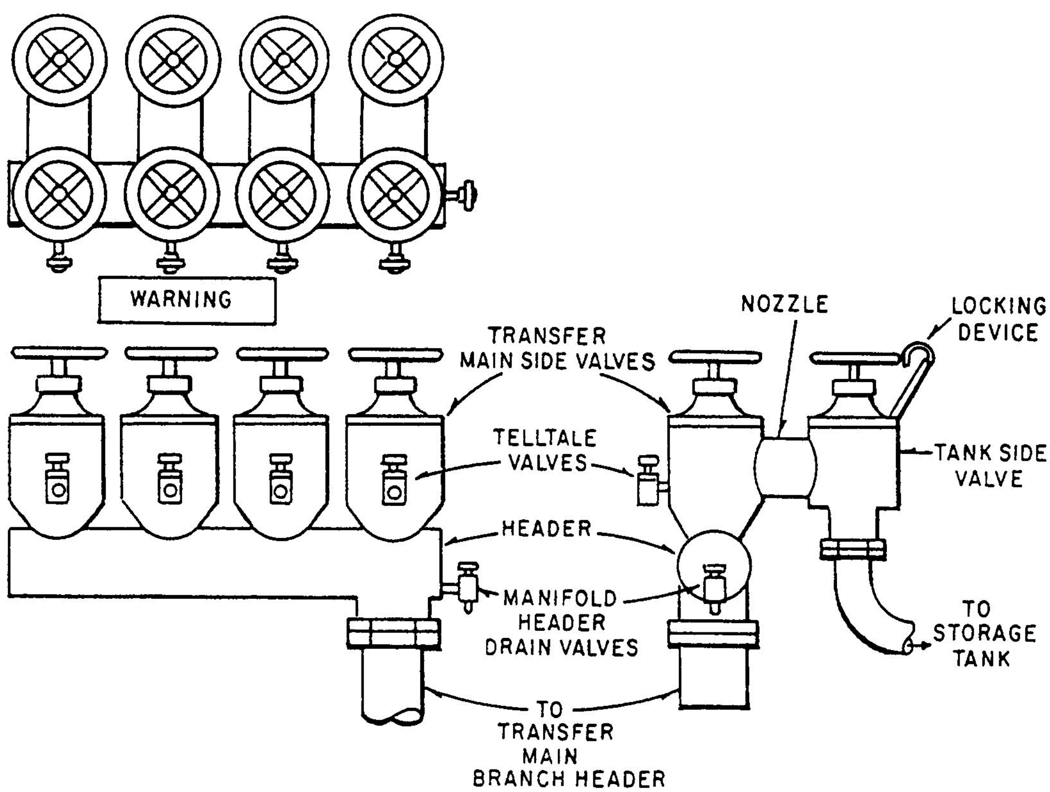
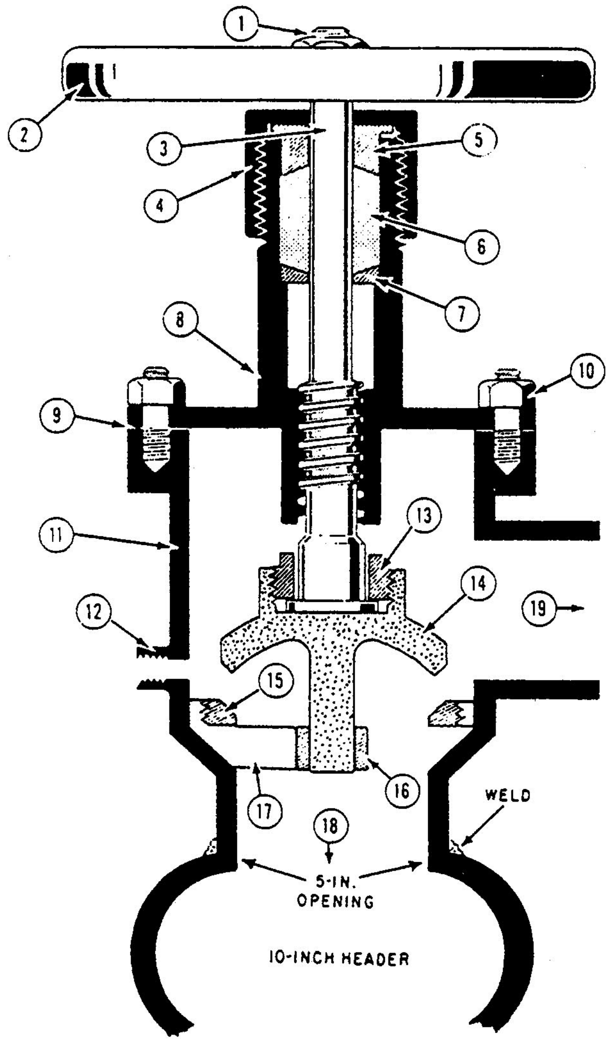


Figure 4-19.—Double-valved manifold.

The transfer mainside valves are specially designed globe valves that are welded to the top of the manifold header (fig. 4-20). They are cylindrical in shape (about 10 inches in diameter) and consist of a body and bonnet. The body houses the seat ring and a guide for the valve disk. Perfect seating of the valve disk with the seat ring is assured by the disk guide centered in the base of the valve body. The lower section of the valve body is welded to the manifold header. A hole is machined in the back of the valve body (above the valve seat) for attaching the nozzle. On the front of the valve body, a hole is drilled and tapped (also above the valve seat) for installing the telltale valve. The bonnet, which provides a working area for the stem, is bolted to the top of the valve body. Leakage of JP-5 is prevented by a gasket between the valve body and bonnet, and packing in the bonnet packing gland around the stem.



1. Handwheel nut
2. Handwheel
3. Valve stem
4. Packing gland nut
5. Gland
6. Stem packing
7. Gland ring (throat bushing)
8. Bonnet
9. Bonnet gasket
10 Bonnet studs and nuts
11. Valve body
12. Connection for telltale valve
13. Disk nut
14. Replaceable disk
15. Replaceable seat ring
16. Disk guide
17. Disk guide ribs (3 equally spaced)
18. Connection (to manifold header)
19. Nozzle (to tank-side valve)

Figure 4-20.—Transfer mainside valve (cutaway).

The tankside valve is identical to the transfer mainside valve, except there is no telltale valve connection and the bottom of the valve body is fitted with a standard pipe flange. The storage tank fill and suction tail pipe that the valve serves is bolted to this flange.

The nozzle is a short section of pipe connecting one transfer mainside valve to one tankside valve in parallel so the two valves serve only one tank.

The telltale valves are small, angle type globe valves installed on the front side of the transfer mainside valves.

NOTE

Most ships are replacing the telltale valve with a GAMMON sample connection. The GAMMON sample connections are less likely to break or leak, and require no maintenance.

There is one telltale valve for each set of manifold valves. These valves are installed on the front side of the transfer mainside valves, above the valve seat. They are used to determine the condition of the valve seats. The telltale valves should be opened periodically. If fuel leaks from the valve, it is an indication either the transfer mainside or the tankside valve is leaking. Both should be inspected as soon as possible and the leaking valve repaired.

The manifold header drain valve is installed at the bottom near one end of the header. It is used to drain the header before maintenance.

A locking device is installed for each of the tankside valves. It is typically a bar with a rotating hook to fit around and locked to the tankside valve handle. It is arranged so the valve can only be locked in the closed position. Tankside valves MUST be locked in the closed position when the tanks are ballasted.

Single-Valved Manifolds

Single-valved manifolds (fig. 4-21) control flow of JP-5 to and from storage tanks designated either JP-5 or JP-5 overflow. These ranks are not ballasted. Single-valved manifolds are also used in the service pump recirculating lines to recirculate fuel back to the service tank, and as tanktop valves in the stripping system.

The single-valved manifold is nearly identical to the tankside half of the double-valved manifold with one major exception. Instead of the nozzle connecting it to a transfer mainside valve, the nozzles in a single valve manifold connect to each other. There is NO transfer mainside valve. A minor difference is single-valved manifolds come in different sizes, based on intended use. A 90-degree ell flanged on one end is used to bolt the single-valved manifold to its respective branch header.

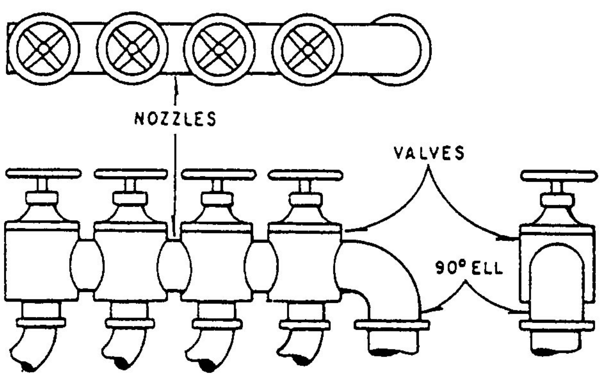


Figure 4-21.—Single-valved manifold.

Flood and Drain Manifolds

Flood and drain manifolds are located in the strip-ping system between the single-valved stripping manifolds and the stripping pumps FOR TANKS DESIGNATED AS JP-5 OR BALLAST only. They are designed to direct the flow of liquids to and from the JP-5 storage tanks during the following operations from one central location:

When designated tanks are ballasted, they direct the flow of sea water from the sea chest supply riser to the single-valves stripping manifold.

When designated tanks are deballasted, they direct the flow of ballast water from the single-valved stripping manifold to the main drainage eductor.

When the designated tanks are stripped, they direct the stripped liquids from the single-valved strip-ping manifold to the suction side of the stripping pumps.

A flood and drain manifold (fig. 4-22) consists of a manifold header and three globe type shutoff valves.

The manifold header is a common valve body for all three valves. It contains three valve seats and forms an unrestricted passage between the three valves above the valve seats. One end of the header is bolted to the single-valved stripping manifold. The other end is sealed. The upper part of the header houses the valve bonnet, which provides a working area for the valve stem. A gasket is installed between the bonnet and the header. A packing gland in the valve bonnet prevents liquids from leaking around the stem. The lower part of the header, below the valve seats, has

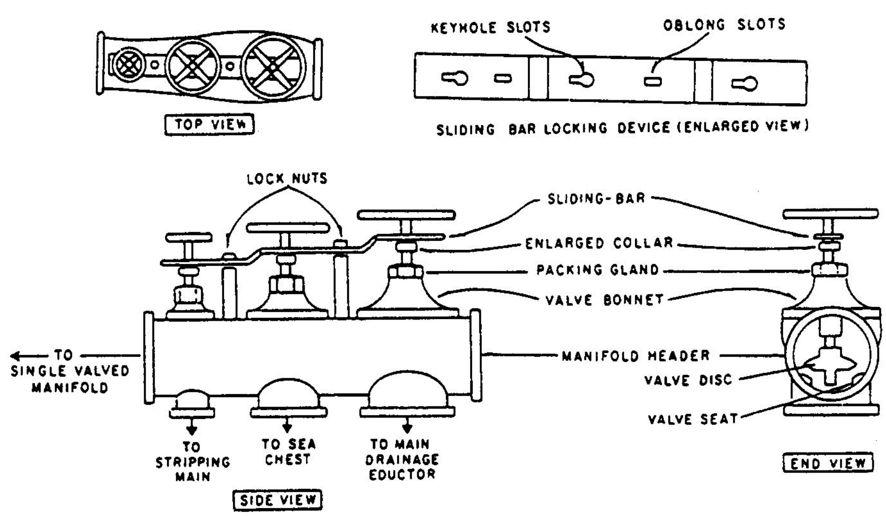


Figure 4-22.—Flood and drain manifold.

three flanged pipe connections, one for each of the three valves.

The stripping line installed just below the stripping valve seat interconnects the flood and drain manifold with the stripping main. This line is used only to direct stripped liquids from the bottom of the JP-5 storage tanks, by way of the single-valved stripping manifold, to the suction side of the stripping pumps.

The center line, installed just below the seat of the sea chest cutout valve interconnects the manifold to a sea chest supply riser. It is used only to direct sea water from the sea chest to the storage tanks during ballasting.

The other line, installed just below the seat of the main drainage eductor valve, interconnects the manifold to the suction side of a main drainage eductor. This line is used only to direct ballast water from the storage tanks to the main drainage eductor when the tanks are being deballasted.

The flood and drain manifold has a locking assembly that allows only one valve to be opened at a time. Therefore, only one operation can be conducted at a time; stripping, ballasting, or deballasting.

Each valve stem has an enlarged collar that engages a sliding-bar locking assembly. Two of the valves are always locked in the closed position. The sliding-bar is actually a long piece of metal containing three keyholes and two oblong slots. It is held in place by two locknuts on a threaded bracket, extending up from the manifold. To open a valve, the sliding-bar must be moved so that the enlarged collar of the valve

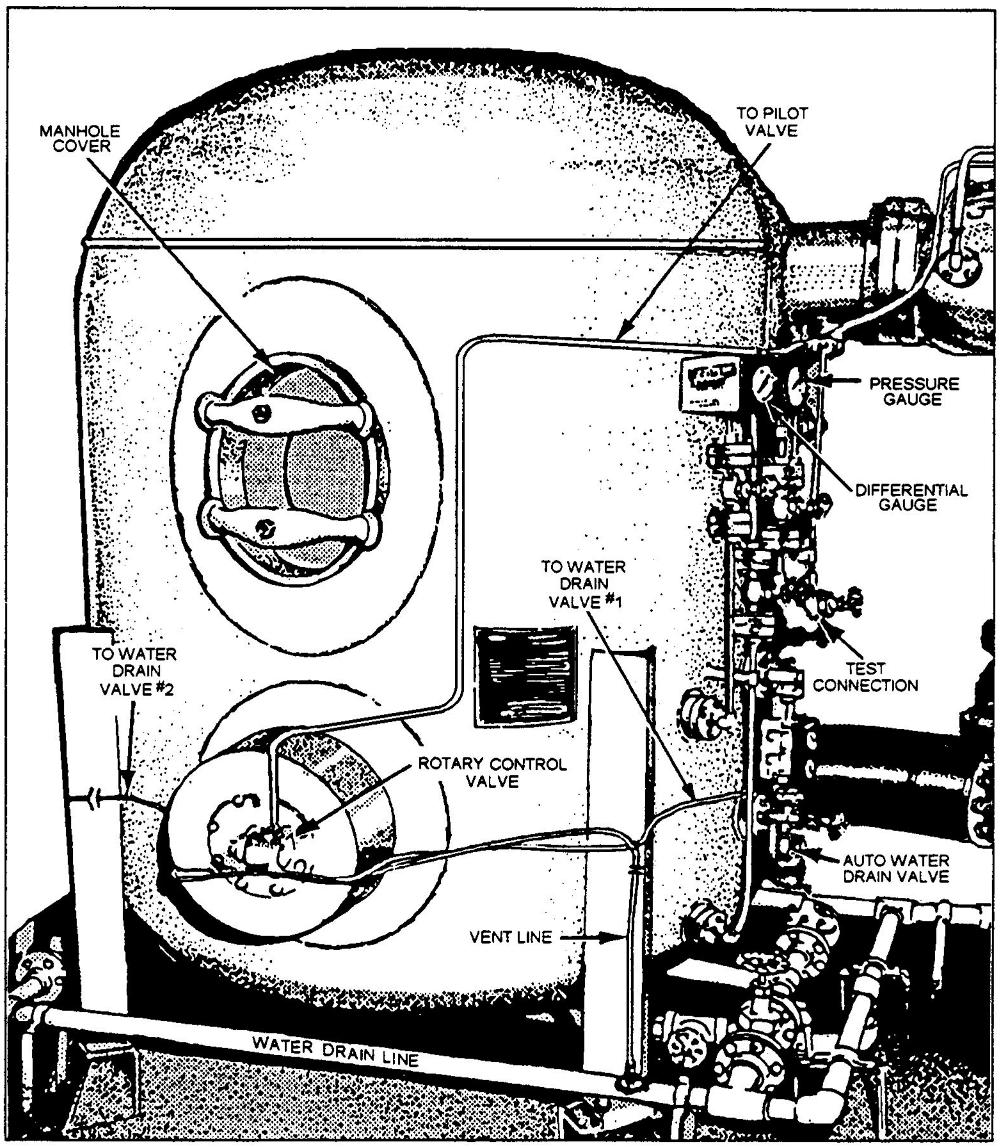


Figure 4-23.-Service fuel filter (vertical).

stem of the valve to be opened is centered under the circular part of the keyhole slot. The three keyhole slots are arranged in the sliding-bar to allow the opening of only one valve at a time. To position the sliding- bar, loosen the two locknuts and slide the bar through the oblong slots to the desired position and tighten the nuts.

SPRAY SHIELDS

Aluminized glass cloth spray shields are designed to prevent JP-5 from spraying on a hot surface or electrical equipment, or forming an atomized mist in the event of a gasket or strainer leak.

In main and auxiliary machinery spaces, spray shields are installed on flanged valve (and valve manifold) bonnets, and flanged joints (including gage lines) on piping containing flammable fluid. For areas outside main and auxiliary machinery spaces, spray shields are installed on flammable fluid piping flanged valve bonnets and flanged joints located in the direct plane of an electrical switchboard, electrical equipment enclosure, or motor.

In the event repairs are required to piping or valve flanges that are covered with spray shields, do NOT reuse spray shields that have fuel on them.

FILTER/SEPARATORS

There are several different types of filters in use in the service and transfer systems in the fleet. But, their principle of operation and hydraulic controls are similar. The major differences are their physical shape and flow direction.

Filters are designed to remove 98% of all solids and 100% of all entrained water from the fuel passing through them. This is accomplished in a two-stage operation by two separate faltering media installed within the filter shell. The first stage consists of a bank of COALESCING elements, surrounded by a hydrophobic screen, that performs the function of removing solids and coalescing water. Coalescing means the bringing together of fine particles of entrained water to form large droplets that then fall out of the fuel by gravity. The second stage consists of a bank of SEPARATOR elements that perform the function of repelling the coalesced water droplets that were too small to fall out by gravity.

The filter is equipped with a float operated rotary control valve that will automatically drain the accumulated water from the filter sump and shut off the filter discharge if more water accumulates than can be drained off automatically. This section will describe typical filter/separators, their operation and maintenance, and their automatic control devices.

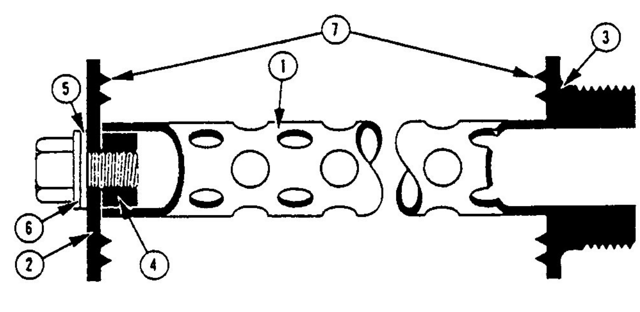
Main Fuel (Service) Filters

The body of the main fuel filter (fig. 4-23) consists of a cylindrically shaped shell with a dome-shaped head welded on each end. The dome-shaped heads provide a uniform flow into and out of the filter. The interior of the filter is divided into an inlet, fall-out, and outlet (clearwell) by tube sheets.

TUBE SHEET.— The tube sheets are circular metal bulkheads installed within the filter shell where the dome-shaped heads are attached to the cylindrical shell. They are welded throughout their circumference to form a leakproof partition between the inlet, fallout, and outlet chambers of the filter. The tube sheets also provide the means of installing the filter element mounting assemblies (both coalescer and separator). Threaded holes, one for each assembly, are symmetrically arranged over the tube sheets surface.

ELEMENT MOUNTING ASSEMBLY.— The element mounting assembly (fig. 4-24) consists' of a perforated metal standpipe about 1 inch in diameter and 24 inches in length, and an end cap. One end of the standpipe is fitted with a threaded base cap to enable screwing it into the tube sheets. The opposite end is fitted with a threaded plug for attaching the end cap. The end cap is a metal disk about the same diameter as the elements.

After the filter element has been placed over the standpipe, the end cap is secured in place by a threaded bolt. A metal washer and fiber washer are provided



1. Standpipe
2. End cap
3. Base cap
4. Threaded plug
5. Fiber washer
6. Metal washer
7. Knife edges

Figure 4-24.—Element mounting assembly.

between the threaded bolt and end cap to prevent leakage at this point.

Both the base cap and the end cap have projecting knife edges. When the elements are mounted on the standpipes, the projecting knife edges are forced into the synthetic rubber gaskets on each end of the elements, forming a tight seal.

COALESCING ELEMENT.— The coalescing element is a cylindrical unit 24 inches long and 3 5/8 inches in diameter. It consists basically of a pleated paper element encased by fiberglass wrappings. The fiberglass is held in place by a cloth sleeve. Each end has a synthetic rubber gasket to form a tight seal and ensure flow through the element when mounted. Flow through a coalescer element is inside to outside.

SEPARATOR ELEMENT.— The separator element has practically the same dimensions as the coalescer, but it is constructed of a different material. It consists basically of a perforated inner brass core cover with a 200-mesh, monel, Teflon-coated screen. This screen is enclosed by an additional aluminum screen. Separator elements are considered permanent and only require cleaning, unless they are damaged, in which case they must be replaced. Flow through a separator element is outside to inside.

Installing Elements.— To install an element on the element mounting assembly, proceed as follows:

1. Make sure the gaskets are in place, then slide the element over the perforated standpipe.

2. Attach the end cap, with metal and fiber gasket in place, and install the threaded bolt fingertight.

3. Center the element on the mounting assembly, and tighten the end cap bolt. The bolts should be torqued to 12 foot-pound or 144 inch-pound.

4. Check the element for tightness.

FILTER INLET CHAMBER.— Fuel enters the filter initially at the inlet chamber. This chamber of the filter is dome-shaped to provide a uniform flow of fuel to all coalescing elements simultaneously. From the inlet chamber the fuel passes through the tube sheet into the coalescing elements in the fallout chamber.

FALLOUT CHAMBER.— The fallout chamber is the center section of the filter shell. It is the largest of the three filter chambers. This area of the filter is provided to allow the coalesced water to fall out of the fuel stream by gravity as it flows from the coalescer elements to the separator elements. Both sets of filter elements are installed in this chamber.

The fallout chamber also contains a manhole cover, filter vent line, and water receiving sump.

The coalescing stage is the first stage of filtration. It consists of a number of individual coalescer elements mounted in symmetrical arrangement on the inlet tube sheet. The fuel leaving the inlet chamber must pass through these elements from the inside to outside before entering the fallout chamber. As the fuel passes through the elements, they perform the dual function of removing solid contaminants from the fuel and coalescing water.

A bolted manhole cover with gasket is installed on the side of the filter shell. This opening is provided to allow personnel to gain entrance to the fallout chamber for replacing elements and maintenance.

A filter vent line is installed at the extreme top of the fallout chamber. This line, fitted with a bull's-eye sight glass, two shutoff valves (one on each side of the sight glass), and a one-way check valve, directs fuel back into the contaminated settling tanks or overboard. The filter is vented until a solid stream of fuel is observed in the sight glass.

The separator stage is the second stage of filtration. It consists of a number of individual separator elements mounted in symmetrical arrangement on the outlet tube sheet.

Fuel leaving the fallout chamber must pass through the separator elements from the outside to the inside before entering the outlet chamber. As the fuel passes through these elements, they repel the final traces of water from the fuel stream. In addition to this primary function, the separator elements also serve as a final filter if one or more coalescer elements rupture. But, separator elements can only filter solids larger than 10 microns.

Water Receiving Sump.— The filter sump is located at the bottom of the filter vessel. The sump receives the water that has been separated from the fuel.

A reflex type sight glass is installed on one side of the sump for observing the water level within. Shutoff valves are installed in the connecting piping for isolating the sight glass during maintenance.

Centrally located on the side or the bottom of the sump is a flanged opening to which is bolted a rotary control valve. This valve is attached to, and mechanically operated by, a ball float housed within the filter sump. The float-operated rotary control valve is a part of the filter automatic hydraulic device. It will be explained in detail later in this section.

OUTLET CHAMBER (CLEARWELL).— This section of the filter is commonly called the "clear-well" because the fuel here is clear of contaminants. It has a dome-shaped head that provides an even, unrestricted flow of fuel from the separator elements.

A test connection for obtaining a sample of the fuel being discharged is located at the bottom of the outlet chamber. When it is necessary to drain the filter completely, the outlet chamber is drained into containers through this line.

Two pressure gages (one for each chamber) and a differential pressure gage are installed on a gage board conveniently located in the filter room. These gages are provided for determining the pressure drop across the filter elements. A shutoff valve is installed in each gage line to permit removal of the gages for maintenance.

OPERATION OF THE MAIN FUEL FILTER.— It is imperative that the filter be properly vented so full use of all filtering elements will occur. JP-5 enters the inlet chamber of the filter. The JP-5 then passes to the inside of the coalescing elements, where solids 5 microns and larger are retained on the inner walls of the elements. As the JP-5 passes through the elements into the fallout chamber, any water is coalesced into large droplets on the outside of the elements. These water droplets fall out of the JP-5 by gravity and into the sump as the JP-5 passes across the fallout chamber to the separator elements. JP-5 enters the separator elements from the outside and, as it passes through the elements to the outlet chamber, any final traces of coalesced water that did not fall are repelled. The JP-5 then leaves the outlet chamber of the filter from the top and flows through the automatic shutoff valve into the forward and aft legs of the quadrant. Rated capacity is 2,000 gpm.

CAUTION

Exercise care at all times when opening and closing valves that govern flow through the filter to prevent a hydraulic hammer shock to the filter. This may overstress the housing or rupture the filter elements.

Immediately after a filter with new elements is placed in operation, the pressure gages must be read and the pressures logged. A pressure differential between the inlet and fallout chambers should be noted. This pressure drop will increase in time due to the buildup of solid contaminants on the inner walls of coalescing elements.

Pressure Checks.— The inlet, outlet, and differential pressure gages should be read and recorded as indicated in the filter operating log. As solids build up on the elements, the pressure drop across the filter increases. The differential gage determines the actual differential pressure across the entire filter assembly. The pressure drop across the coalescer elements is the most critical.

As the maximum allowable pressure drop across the coalescing elements is reached, they fail to perform their designed function and must be replaced. The maximum allowable pressure drop limits for coalescer elements are found on the instruction sheet in the manufacturer's packing crate. Although pressure drop limits may vary, 15 psi is the typical pressure drop limit.

Sample Checks.— Daily checks are taken from the filter sump and outlet chamber at the beginning of initial flow and every 15 minutes thereafter. The contents of each sample should be recorded in the operating log. These samples can be used to determine the condition of the coalescer and separator elements.

If the sample taken from the filter sump contains solids, it is a probable indication that the coalescer elements have failed. If the sample taken from the outlet chamber is contaminated, it is a probable indication that the coalescer and/or separator elements have failed. In either case, the elements should be inspected and replaced as necessary.

Also, coalescer elements should be replaced at each overhaul and before deployment. If no overhaul or deployment occurs, they should be replaced in accordance with PMS. When coalescer elements are replaced, separator elements should be cleaned and inspected. Only defective separator elements need be replaced. Coalescer elements of one manufacturer may be used with the separator elements of another manufacturer.

FILTER HYDRAULIC CONTROL SYSTEM.— The filter hydraulic control system is a safety device installed on all fuel filters. It functions to drain automatically the accumulated water from the filter sump, and to shut off the filter flow if more water accumulates than can be drained off automatically.

This system consists of three hydraulic control valves and afloat operated control valve. Two hydraulic control valves (the automatic shutoff valve and pilot valve) are located in the filter discharge line. The other hydraulic control valve (the automatic water drain valve) is located in the filter sump drain line. The float operated control valve (rotary valve) is located on the side or bottom of the filter sump.

Automatic Shutoff Valve.— The automatic shutoff valve is of a modified globe valve design, using a well supported and reinforced diaphragm as a working means. A tension spring located in the upper valve chamber (above the diaphragm) assists in seating the valve when closing, and provides a cushioning when opening. The valve is opened by filter discharge pressure acting under the valve disk. The valve is closed by filter discharge pressure acting with the tension spring on the top of the diaphragm in the valve cover chamber. The pilot valve and an eductor, both located in the actuating line, control the opening and closing of the automatic shutoff valve.

The actuating line runs from the inlet to the discharge side (by passing the valve seat) of the automatic shutoff valve body.

The pilot valve is of the modified globe valve design, having a double-acting diaphragm as its working means. When fuel pressure is applied to the top of the diaphragm, the valve closes (closing off the actuating line). When fuel pressure is applied to the bottom of the diaphragm, the valve opens (allowing flow through the actuating line).

The eductor is located in the actuating line between the pilot valve and the inlet side of the shutoff valve. The eductor suction line is connected to the top of the shutoff valve cover chamber. With the pilot valve open, the eductor decreases the fuel pressure on top of the diaphragm of the shutoff valve by educting fuel from the main valve cover chamber. This decrease in fuel pressure on top of the diaphragm allows filter discharge pressure acting under the shutoff valve disk to open the valve. When the pilot valve closes, filter discharge pressure in the actuating line is directed through the eductor suction line to the top of the cover chamber of the shutoff valve. This increase in fuel pressure on top of the diaphragm cover overcomes the fuel pressure being applied on the valve disk and closes the valve. Simply put, if the pilot valve is open, the automatic shutoff valve is open. If the pilot valve is closed, the automatic shutoff valve is closed.

Automatic Water Drain Valve.— This valve, located in the water drain line from the sump, is identical to and functions in the same way as the pilot valve. When fuel pressure is applied to the top of the diaphragm in the automatic water drain valve, the valve closes and stops the flow from the filter sump. When the fuel pressure is relieved, the valve opens and allows water to be discharged from the filter sump. Vertical filters have two automatic water drain valves.

Float Operated Rotary Control Valve.— The rotary control valve, located on the side or bottom of the filter sump, is operated by the rise and fall of a captivated ball float housed within the filter sump.

The ball float is attached to the rotary valve by a float arm and gear assembly. It is designed to float on water and sink in JP-5. The rotary control valve described here is the one typically installed on vertical filters.

The rotary control valve has three operating positions: DOWN, HORIZONTAL, and UP. The valve body has four ports. Three of the ports are connected by tubing to the following:

1. A drain (vent) port to the water drain line on the discharge side of the automatic water drain valve
2. A port to the top of the diaphragm in the pilot valve
3. A port to the top of the diaphragm in the automatic water drain valve

The fourth port is the supply connection. It is on the top of the rotary control valve inside the filter vessel. The port is fitted with a wire mesh strainer.

The rotary control valve, through the action of the ball float, controls the opening and closing of the automatic water drain and pilot valves.

OPERATION OF THE FILTER HYDRAULIC CONTROL SYSTEM.— AS long as the fuel passing through the falter contains little or no water, the rotary control valve float will remain it its DOWN position. With the float in its DOWN position, the rotary control valve directs fuel to top of the diaphragm of the automatic water drain valve (keeping that valve closed), and vents fuel pressure from the top of the diaphragm in the pilot valve. Direct fuel pressure applied to the bottom of the pilot valve diaphragm opens that valve, which allows filter discharge pressure to open the automatic shutoff valve.

As coalesced water collects in the filter sump, the float rises to the horizontal position. With the float at its horizontal position, the rotary control valve vents the top of the automatic water drain valve allowing direct fuel pressure to force it open and drain the accumulated water. The top of the pilot valve diaphragm continues to be vented while direct fuel pressure continues to be applied to the bottom of the pilot valve diaphragm, keeping it open, which allows discharge pressure to open the automatic shutoff valve.

If water collects in the filter sump faster than it can be drained off, the float will rise to its UP position. With the float at its UP position, the rotary control valve directs pressure to the top of the pilot valve (closing it) which causes the automatic shutoff valve to close, stopping fuel discharge. The top of the automatic water drain valve continues to be vented allowing direct fuel pressure to keep it open to drain the accumulated water.

Simply put,

With the float in the down position: the pilot valve is OPEN; the automatic shutoff valve is OPEN; and the automatic water drain valve is CLOSED.

With the float in the horizontal position: the pilot valve is OPEN; the automatic shutoff valve is OPEN; and the automatic water drain valve is OPEN.

With the float in the up position: the pilot valve is CLOSED; the automatic shutoff valve is CLOSED; and the automatic water drain valve is OPEN.

TROUBLESHOOTING THE FILTER HYDRAULIC CONTROL SYSTEM.— If the system fails to operate properly, make the following tests:

1. Check the arrows on the automatic shutoff, pilot, and automatic water drain valves to ensure proper installation.

2. Make sure all manually operated valves are properly aligned.

3. Inspect the tubing for dents, flat spots, or internal obstructions.

NOTE

The latter is often the most likely cause of the malfunction.

If the above tests prove unsatisfactory, the rotary control valve should be removed for inspection and further testing. Cunsult the appropriate technical manual.

First-Stage Filters

First-stage filters (fig. 4-25) are commonly known as reclamation filters. That is because these filters are typically used in the JP-5 reclamation

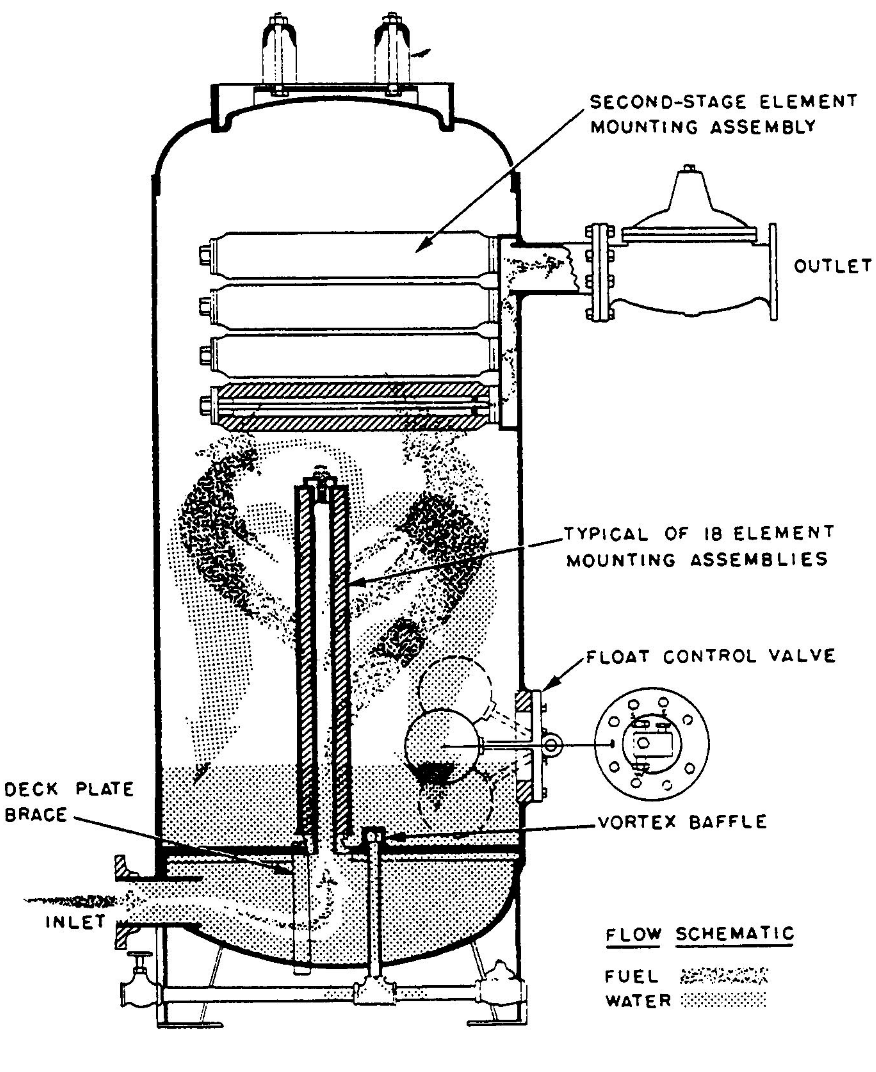


Figure 4-25.—First-stage filter.

system to filter the fuel from the contamination tanks before pumping it back into storage tanks.

These filters normally have a rated capacity of 300 gpm and an operating pressure of 100 psi. The filter is designed to remove 98% by weight all solids 5 microns or larger, and 99.9% of the water. The filter has a cylindrically shaped, welded, copper-nickel shell mounted on three legs. A bolted handhole cover assembly at the top of the shell provides access to remove or replace coalescer or separator elements. The interior of the shell is divided into three chambers: inlet, fallout, and outlet. The inlet chamber is at the bottom of the shell; the fallout chamber contains coalescer and separator elements: and the outlet chamber (clearwell) connects to the discharge piping.

The outside of the shell contains a reflex-type sight glass, differential gage, and an outlet pressure gage. The sight glass indicates water level in the fallout chamber. The differential gage indicates the pressure drop across the coalescer elements. The outlet gage indicates the pressure of the filtered fuel after it has passed through the separator elements and before it leaves the filter.

There are 18 coalescer elements mounted vertically on the horizontal deck plate. Fuel flows from the inlet chamber through the coalescer elements to the fallout chamber.

There are 11 separator elements mounted horizontally in individual mounting assemblies attached to the outlet chamber. Fuel flows from the fallout chamber, through the separator elements, and into the outlet chamber.

A float control valve, bolted to a flange that is welded to the shell, controls the action of an automatic water discharge valve and an automatic shutoff valve in the exact way as the vertical filter. In fact, with the exception of rated capacity, this filter operates exactly the same as the vertical filter.

Prefilters

Prefilters are provided upstream of first-stage filters to reduce the burden on and extend the life of the coalescer elements installed in first-stage filters. Basically, the prefilter consists of a cylindrical housing with valved vent and drain connections, and a differential pressure gage. The elements are a disposable type designed to remove solid contaminants.

CENTRIFUGAL PURIFIER

Centrifugal force is defined as that force which impels a thing (and any or all of its parts) outward from a center of rotation. Every time you lean in as you take a fast turn, you are counterbalancing centrifugal force. How far in you lean is determined by the amount of centrifugal force exerted in the turn. Most people do it automatically, for centrifugal force, along with gravity, is the most prevalent physical force exerted upon us and upon all matter.

The purpose of the centrifugal purifier (fig. 4-26) in the JP-5 filling and transfer system is to separate and remove water, solids, and emulsions from JP-5 during transfer from storage to service tanks. The diskbowl centrifuge is a “constant efficiency” type of separator; that is, it achieves the same degree of efficiency at the end of a run as at the beginning. The reason for the constant efficiency is that accumulated solids are stowed away from the separation zone. Separation occurs within the disk spaces, and the separated liquids are discharged from outlets that are removed from interference of the stowed solids.

Theory of Operation

Dirty fuel containing water and solids is fed to the purifier through the feed inlet of the inlet-outlet assembly. The dirty fuel then enters the top of the bowl centrifuge through the feed tube and travels down the tubular shaft, to be thrown outward and upward by the distribution cone at the bottom of the distributor, under the disk stack. The fuel is forced upward through the distribution holes in the intermediate disks, where centrifuge action separates the fuel, water, and solids.

The solids are thrown directly against the bowl wall and collect in a uniform layer on the inside vertical surface of the bowl shell. The water, thrown outward, is displaced by incoming feed material forcing the water overflow up and over the outer edge of the top disk, and discharging it through the discharge ring and the heavy phase outlet.

The clean fuel, which has a lesser density, is displaced inward and upward along the outside of the distributor to the paring disk chamber, where the spinning fuel contacts the edge of the stationary paring disk. The paring disk then acts as a pump, discharging the fuel to the purifier fuel outlet.

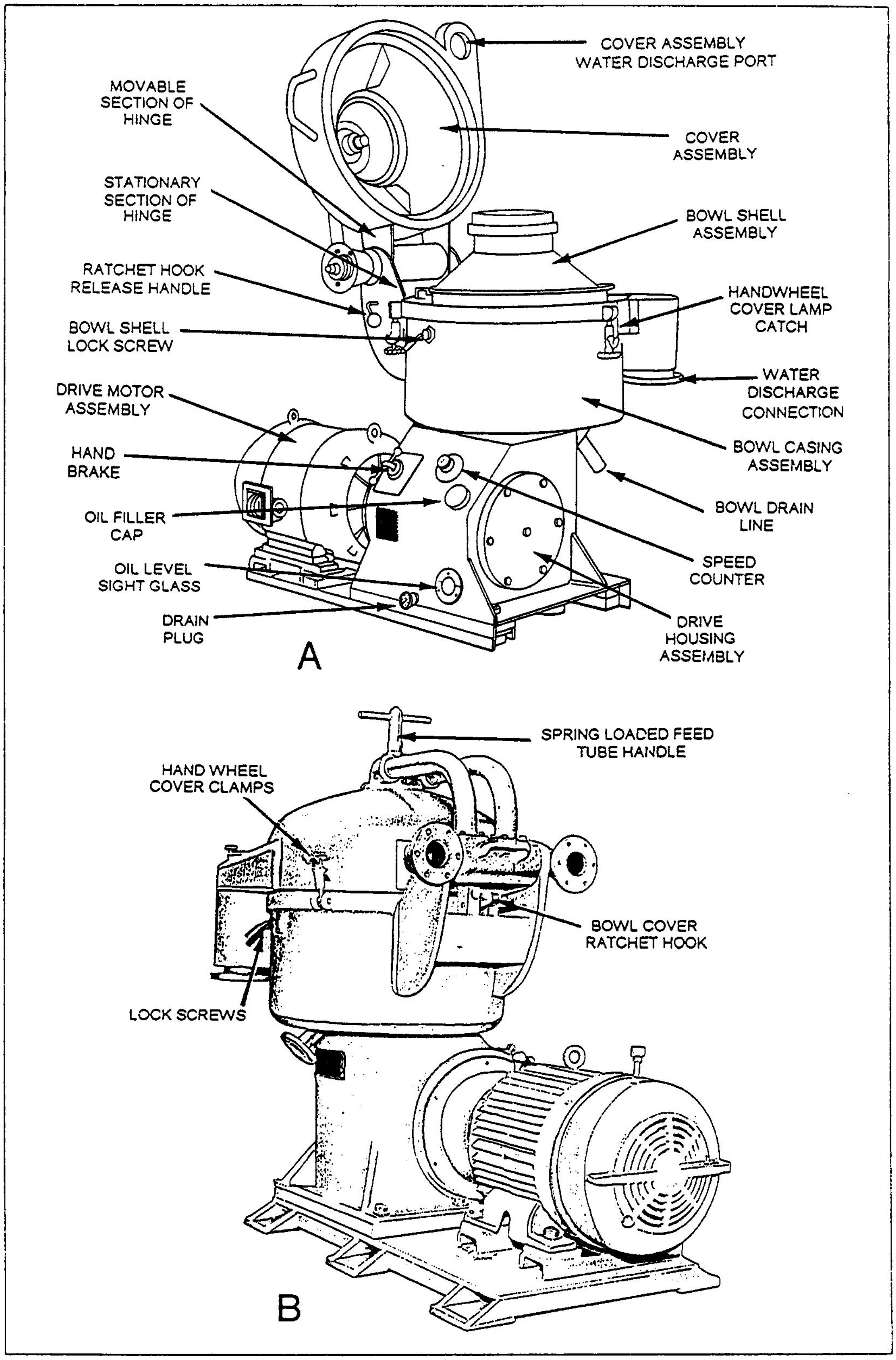


Figure 4-26.—Centrifugal purifier.

Characteristics of the centrifugal purifier are

- Capacity—200 gpm at 60°F to 90°F when purifying JP-5 (fuel temperature);
- Feed inlet pressure—9 psi;
- Back pressure of the discharged JP-5:
- Minimum—25 psi,
- Ideal—30 psi,
- Maximum—35 psi, and
- Bowl speed—4,100 rpm.

Some purifiers are being modified during shipyard periods to purify 300 gpm. Consult the technical manual for operational changes.

Cover Assembly

The cover assembly (fig. 4-27) completely encloses the top of the rotating-bowl shell assembly. The cover hinges to the bowl casing, thus allowing the cover to be lifted out of the way for disassembly and cleaning of the bowl. (See figure 4-26.)

The cover hinge, inlet, and outlet assembly functions to allow the cover to be opened without disconnecting the piping. The stationary part of the hinge is welded to the bowl casing, The movable part of the hinge is welded to the cover. A ratchet hook is provided on the stationary part of the hinge to lock the cover in the open position. A handle is provided to unlock the hook so the cover can be closed. Inlet and outlet piping connects through the hinge to the inlet and outlet tubes. The piping is stationary, but the tubes rotate with the cover. A chevron-shaped, oil-resistant rubber seal is installed between the piping and tubing to prevent leakage. Fuel pressure spreads the chevron rings to make a tight seal. When fuel flow is stopped, pressure ceases, and the chevron seals loosen enough to allow the cover to be rotated to the open position.

The feed inlet tube and the purified JP-5 discharge tube both connect into the feed tube assembly at the top of the cover. An oil-resistant seal (0-ring) prevents leakage of liquids between each tube and the feed tube assembly. The feed tube assembly directs feed into the revolving bowl and purified JP-5 out of the bowl.

A seal-water inlet, located between the inlet and discharge tubes, directs fresh water into the revolving bowl for use as a seal. A 3/4-inch plug valve and

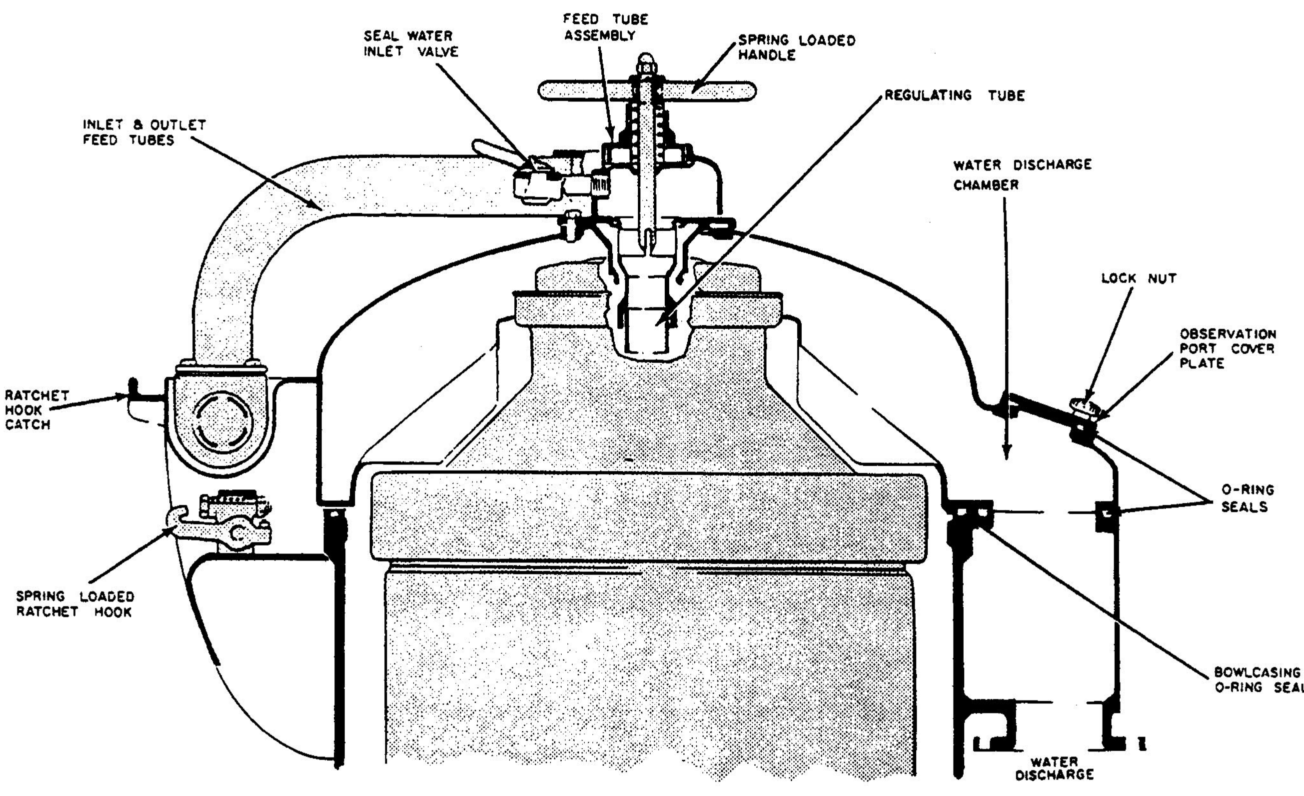


Figure 4-27.—Cover assembly.

flexible rubber hose connect the seal-water inlet to the fresh water supply in the pump room.

NOTE

As of this writing, steel-braided jacketed hose is being installed during available yard periods to replace the flexible-rubber seal-water hose.

Internally, the feed tube assembly is constructed to direct the feed and the seal water to a nylon regulating tube. The regulating tube then directs this liquid to the center of the tubular shaft (part of the bowl shell assembly).

The feed tube is also the shaft for the paring disk. The spring-loaded handle, extending out the top of the feed tube assembly, is used to screw the feed tube into the paring disk. The handle remains down when the two are engaged. When not engaged, the spring forces the handle and feed tube up and away from the paring disk.

CAUTION

The feed tube has left-hand threads. The feed tube must be disengaged from the paring disk before the cover can be opened.

Equally spaced around the bottom of the cover are three handwheel cover clamp catches. These hook-shaped catches are used to lock the cover in the closed position.

Inside the dome-shaped cover is the water-discharge chamber. This chamber normally receives the water discharged from the revolving bowl. This water is directed to the water-discharge outlet area of the water-discharge chamber. An observation port is provided to enable a visual check of the discharging water. The port has a metal cover that is swung to one side when it is opened. The port, when open, is just a hole. No glass or other transparent medium is provided to cover the open port.

Bowl Casing

The bowl casing is a circular stationary tub that houses the rotating-bowl shell assembly. The stationary part of the cover hinge, inlet, and outlet assembly is welded to the outside of the bowl casing.

Three handwheel cover clamps are equally spaced around the top of the bowl casing to lock the cover in the closed position. Each handwheel cover clamp has a hook that engages the catch on the cover. Rotating the handwheel screws the hook down upon the catch, which in turn pulls the cover down. Handtight is sufficient for proper locking of the cover in the closed position. A large oil-resistant ring provides a liquid-tight seal between the cover and the bowl casing when the cover is closed.

Two bowl-shell lock screws (fig. 4-28) are housed in the upper part of the bowl casing. These locking devices lock the bowl shell assembly during disassembly and assembly. They are engaged to prevent the bowl shell assembly from rotating. A threaded bushing in the bowl casing allows the lock screws, which are also threaded, to be screwed into or out of the lock position. When the lock screws are in the lock position, they engage a slot in the revolving-bowl shell assembly.

CAUTION

The two bowl-shell lock screws must be removed before starting the purifier. Two bowl-shell lock screw plugs are provided to plug up the threaded hole in the bowl casing when the lock screws are removed.

A water-discharge connection is welded to the upper portion of the bowl casing. This connection is aligned with the water-discharge connection in the cover assembly when the cover is closed. An

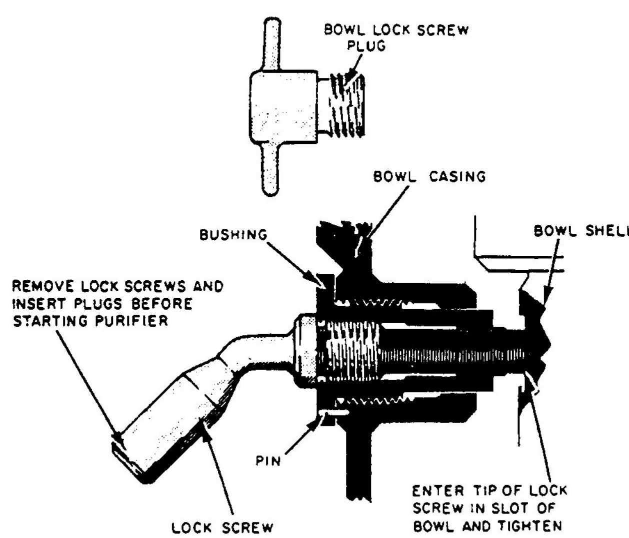


Figure 4-28.—Bowl-shell lock screw and plug.

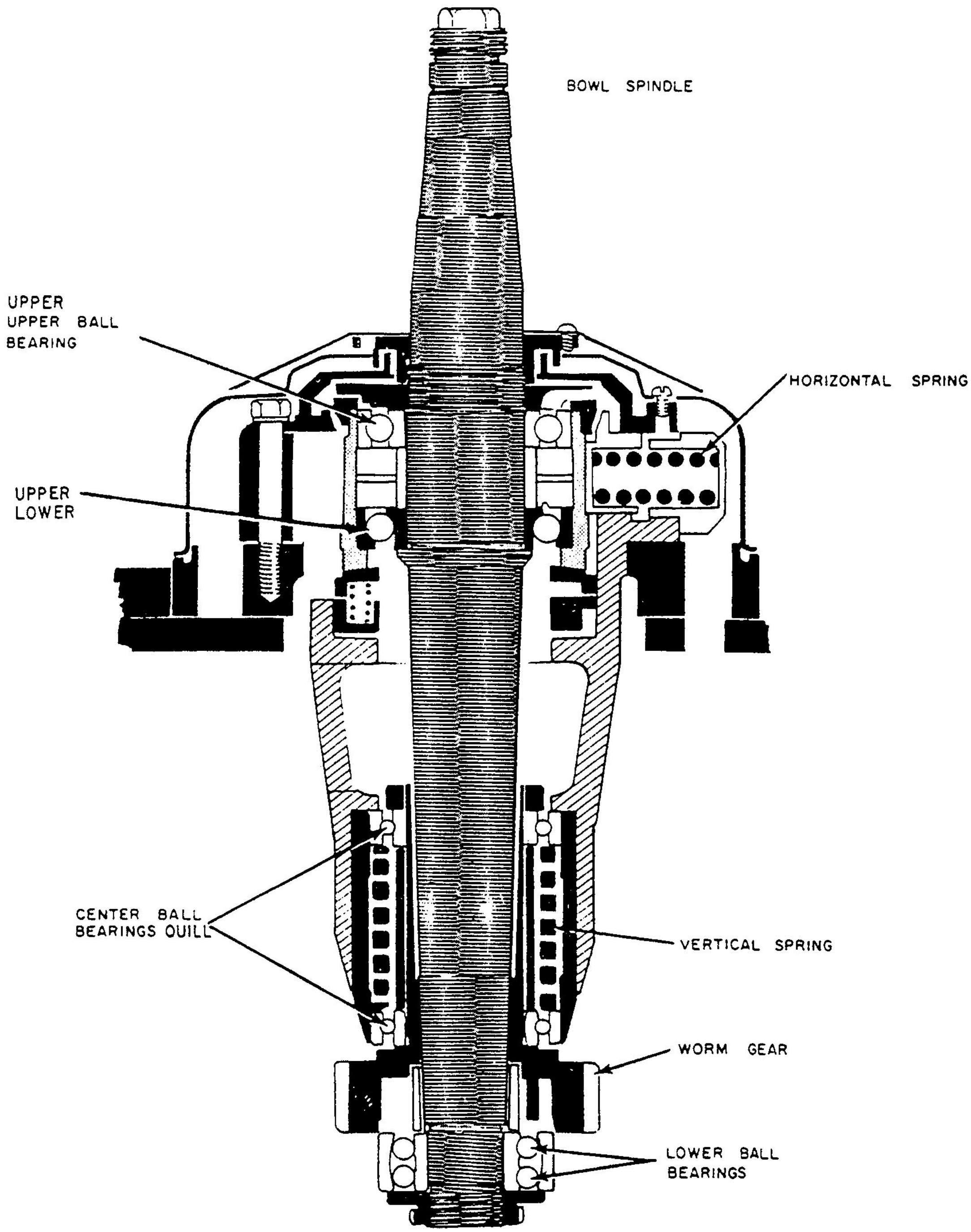


Figure 4-29.—Spindle assembly.

oil-resistant 0 ring forms a liquid-tight seal between the water-discharge connections of the cover and bowl casing when the cover is closed. The lower end of the bowl casing's water-discharge connection is flanged to the water-discharge line. The water-discharge line directs water into a sump tank. The water-discharge line contains a flexible pipe connection between the purifier and the connection piping that is firmly braced to the ship's structure. This flexibility allows for safe passage through the critical vibration range when starting and stopping the purifier.

A bowl casing drain line protrudes from the bottom of the bowl casing. This line drains any liquid that may enter the annular space between the revolving bowl shell assembly and the stationary bowl casing. A locked-open globe valve is installed in this line. It is imperative that this valve be open before starting and during starting, operating, and stopping cycles of the purifier. The bowl casing drain line directs drained liquid into the sump tank. A short length of rubber hose is installed in this line to perform the same function as the flexible pipe connection in the water-discharge line.

Drive Housing and Assemblies

The drive housing bolts to and supports the bowl casing, cover, and bowl shell assembly. The drive housing contains the spindle assembly, direct drive assembly, speed counter, brake, and lubrication system.

The spindle assembly (fig. 4-29) is the vertical drive shaft for the bowl shell assembly. Three sets of ball bearings support the spindle assembly; a set at the top, a set at the center, and a set at the bottom. All three sets of ball bearings are lubricated by oil. Located between the upper and lower bearings of the center set of ball bearings is a large vertical spring. This spring acts as a shock absorber to absorb any vertical thrust of the spindle's shaft when the purifier is started. Six equally spaced horizontal springs surround the upper set of ball bearings. These springs absorb and cushion any horizontal movement of the bowl shell assembly and thus reduce vibration. The lower end of the spindle's shaft is geared to the horizontal drive shaft of the direct drive assembly. The direct drive assembly transmits drive motor power to the spindle, which, in turn, transmits power to the bowl shell assembly. The direct drive assembly (fig. 4-30) connects the purifier to the motor shaft by a flexible coupling. The coupling consists of two coupling halves, with the motor end fitted to the motor shaft and the purifier end fastened to the brake drum with four bolts. Each coupling half has protruding studs (which are offset of each other) that engage a rubber cushion installed between the two coupling halves.

The drive motor shaft turns the coupling, which turns horizontal drive shaft. The horizontal drive shaft is supported by two ball bearings; an outer and an inner bearing. The outer and inner shaft bearings are lubricated by oil. A worm wheel gear is keyed to the drive shaft. This gear engages the gear at the base of the spindle assembly. A smaller gear, which is part of the worm wheel gear, is used to drive a speed counter.

The speed counter (fig. 4-31) is used to determine the rpm of the bowl shell assembly. Basically, it consists of a shaft that penetrates the drive housing. One end is

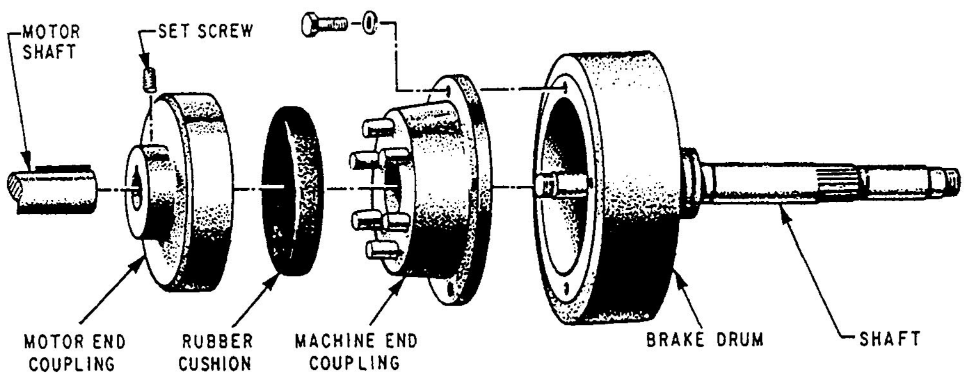


Figure 4-30.—Direct drive assembly.

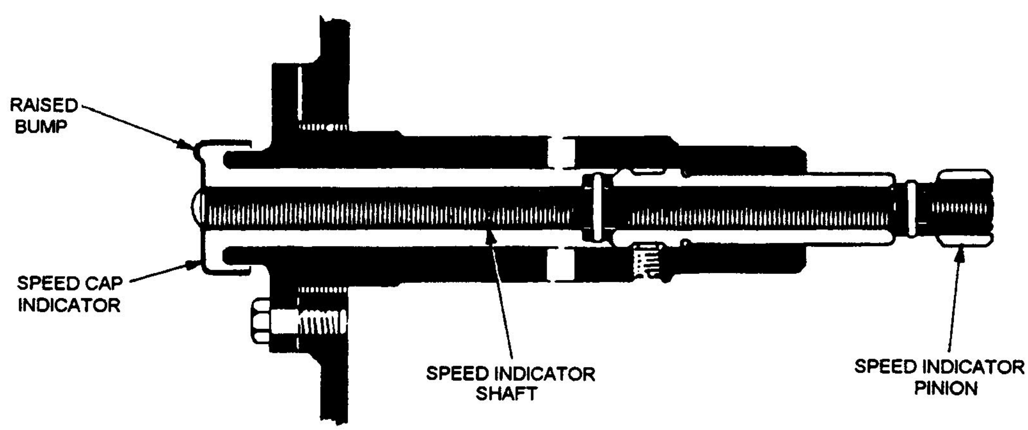


Figure 4-31.—Speed counter.

inside the drive housing and the other end is outside. The inside end is geared to the worm wheel gear; therefore, when the direct drive assembly rotates, the speed counter shaft rotates. The speed counter, but, rotates at a much slower rate because of the gear ratio. The outside end of the speed counter shaft is covered by an attached cap. The cap has a raised bump on one side of its top. Bowl speed is determined by the operator who places his finger on the outer edge of the cap and then counts the number of times the raised bump touches his finger in 1 minute. During full bowl rpm, the count should be between 146 and 150 times per minute.

Because of the gear ratio, the drive motor rotates at 1,770 rpm, the bowl rotates at 4,100 rpm, and the speed counter rotates at 146 to 150 rpm. A handbrake (fig. 4-32) is provided to stop the purifier. This brake is for emergency use only. It consists of a spring-loaded brakeshoe and an eccentric handle. The brakeshoe has a replaceable section of bonded brake lining. When the handle is down, the brake is off. When the handle is raised to the up position, the brake is on. In the on position, the spring forces the brakeshoe and lining against the outer surface of the brake drum. Friction, thus created, causes the purifier to come to a stop.

In the base of the drive housing is an oil sump for the oil lubrication system (fig. 4-33). All the bearings on the spindle and drive shaft are lubricated by this oil. The drive housing is divided into two compartments. One of these compartments contains the direct drive assembly coupling and the other contains the gears and bearings that are lubricated by oil. A metal partition separates the two compartments. The direct drive shaft passes through this partition and a gasket is installed around the shaft to prevent oil from entering the direct drive coupling compartment. The worm wheel gear on the drive shaft is partially submerged in the oil. Rotation of this gear splashes the oil about within the oil

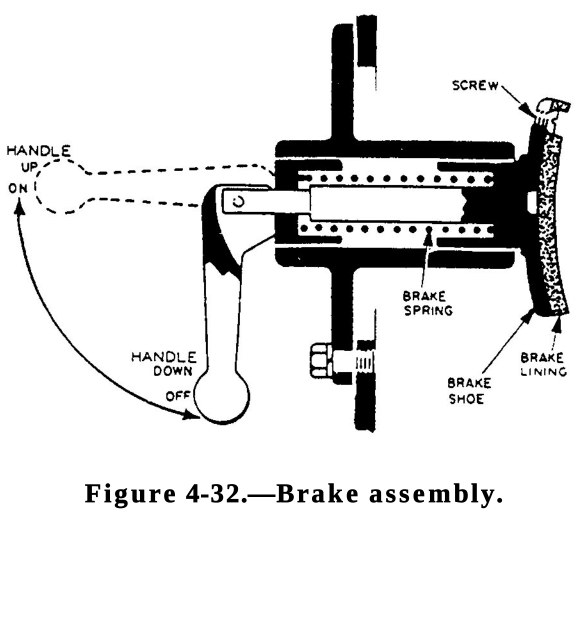


Figure 4-32.—Brake assembly.

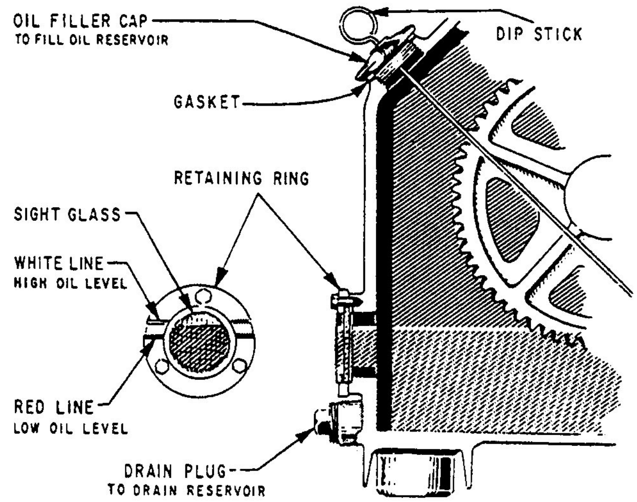


Figure 4-33.—Oil lubrication system.

lubrication compartment, thus supplying oil to the bearings and gears. The oil sump holds from 8 to 8 1/2 quarts of grade 90 gear oil. Proper oil level is determined by a circular sight glass on the side of the drive housing. The glass retaining ring has two inscribed lines to indicate proper oil level. The white, top line, is the high or full oil level. The red, bottom line, is the low oil level mark.

On some installations where the oil sight glass could not be seen easily in its normal position, the sight glass has been extended out and turned to give a clear view to the operator, or a dip stick has been added to the oil filler cap. The dip stick has two marks. The lower mark indicates lubricating oil should be added. Fill to the upper mark. To check the oil level, pull the stick completely out through the cap. Wipe with a clean, dry rag. Push the stick all the way in through the cap and pull it out again to read. Be sure the stick always rests on the cap.

An oil fill cap is located near the top of the drive housing. An oil drain plug is at the base of the oil sump.

Bowl Shell Assembly

The bowl shell assembly (fig. 4-34) provides the working area for separation of contaminants from JP-5. The entire bowl shell assembly sits on top of the spindle assembly. The spindle assembly causes the bowl shell assembly to rotate. This rotation is transmitted to the fuel, thus providing the necessary centrifugal force to cause separation to take place. During operation, the bowl shell assembly contains a fresh water seal to prevent loss of the JP-5. Most of the separated solids and emulsions are retained within the bowl shell assembly, but are completely removed from the line of flow of the liquids.

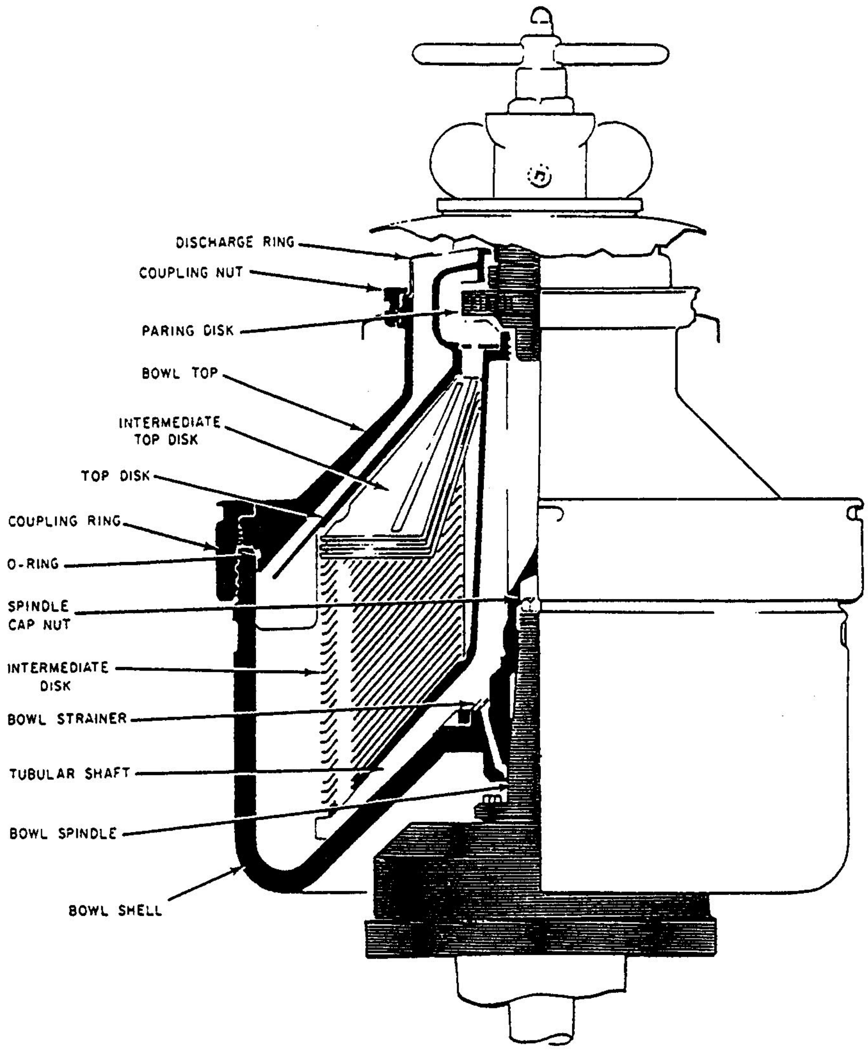


Figure 4-34.—Bowl shell assembly.

The bowl shell confines the liquids being separated. Housed within the "tub-like" bowl shell are the strainer, disk stack, paring and discharge ring.

The bowl shell has eight equally spaced drain holes around the raised center of its bottom. These holes facilitate draining the bowl when the purifier is in its stopping cycle. The draining liquids are directed into the annular space between the bowl shell and the bowl casing and then out the bowl casing drain line.

To ensure that the drain holes will not become clogged by dirt from the bowl shell, a conical-shaped strainer is installed over the top of the drain holes.

The bowl shell seats on the tapered portion of the top of the spindle shaft. The threaded top section of the spindle shaft protrudes up through the raised center of the bowl shell. A spindle capnut is then screwed down over the threads to force the bowl shell down onto the tapered portion of the spindle shaft.

A slot is provided on each side of the bowl shell on its outer surface near the top. These two slots engage the bowl shell lock screws during disassembly or assembly of the bowl shell. A notch at the upper/outside edge of the bowl shell engages the bowl top.

The tubular shaft is the base and the center of the disk stack. It forms a circular bulkhead between the feed inlet liquids and the disk-stack discharge to the paring disk.

The base of the tubular shaft has three unequally spaced pins that interlock with three unequally spaced slots around the raised center of the inside-bottom of the bowl shell. Thus, the tubular shaft can be installed in one position only, ensuring that the tubular shaft will rotate.

The flared base of the tubular shaft is the bottom of the disk stack. A liquid passage. between the bowl shell and the underside of the tubular shaft's base, is provided by 12 inner spacers. The inner spacers are part of the tubular shaft, and serve two purposes-they keep the tubular shaft off the bowl shell to provide the liquid passage, and they give a circular motion to the feed inlet liquid, since they act as rotating paddles. The 12 inner spacers run from the top-inside area of the tubular shaft and follow its contour down and under the flared base to the outer edge of the base.

Twelve equally spaced holes are provided near the outer edge of the tubular shaft's flared base. These holes are located between the 12 inner spacers.

The outer edge of the tubular shaft above the flared base has 12 equally spaced outer spacers. These outer spacers perform the same function for the purified JP-5 that the inner spacers perform on the feed inlet liquids. One of the outer spacers has a key to which each of the disks in the disk stack lock. This ensures that the disks will rotate.

The intermediate disks form the main part of the disk stack. There are 127 individual intermediate disks. Each has a number stamped on its top side near its outer edge. The disks are numbered 1 through 127; number 1 disk is on the bottom and number 127 is on the top.

NOTE

Additional intermediate disks can be added to the top of the intermediate disk stack to make sure correct disk stack compression is maintained.

The intermediate disks are identical except for their stamped numbers. In shape, the disk resembles a metal lampshade, large at its base and small at the top. A small lip flares out from the base and a small lip flares inward from the top.

Twelve equally spaced holes are located around the base of the disk. A thin sliver of metal (0.050-inch thick) runs from between each hole inward to the inner lip. These pieces of metal, located on the top of each intermediate disk, act as spacers. Since the disks seat one on top of the other, the thickness of the space between each disk is determined by the thickness of the spacers.

The top inner lip of each intermediate disk has a notch that interlocks with the key on the tubular shaft. This interlocking ensures that the disks rotate and that the disk holes will be aligned vertically.

Some purifiers will have an intermediate top disk that seats on top of the topmost intermediate disk. Its purpose, also, is to ensure correct disk stack compression. This disk is similar in construction to the 127 intermediate disks except that the flared lip around its base is only half as large as the lip on the intermediate disks, and it does not have a stamped number or the raised ribs.

The top disk seats on top of the intermediate top disk and is the top disk of the disk stack. Being wider than the other disks in the stack, the top disk covers the disk stack like an umbrella. This is the only disk that does not have holes around its base. The inner-upper portion of the top disk is the pump casing for the paring disk. The lower portion of the pump casing has a notch that interlocks with the key on the tubular shaft, thus insuring that the top disk will rotate.

Twelve outer spacers, equally spaced around the top side of the top disk, extend from beyond the rim of the base inward to the top of the pump casing. The outer end of each spacer extends below and partially up the underside of the top disk. These spacers perform the same function to separated water as the outer spacers on the tubular shaft perform on the purified JP-5.

A vane-type centripetal pump, the paring disk, is housed within the pump casing area of the top disk. The paring disk does not rotate; it is threaded onto the feed tube assembly (see "Cover Assembly"). In this pump, the pump casing revolves around the impeller; thus, the flow is from the outside/in. This flow, being centripetal, is just the reverse of a centrifugal pump. The feed tube of the cover's feed tube assembly is the pump shaft. A nylon collar fits snugly around the top of the paring disk. When the feed tube is screwed into the paring disk, the paring disk is raised until the nylon collar contacts the upper/inside area of the pump casing. In this position, the nylon collar acts as a wearing ring for the paring disk.

A bowl top seats on the top of the top disk's spacers. Discharging water flows up through the space between the top disk and the bowl top. The conical-shaped bowl top is thicker at the bottom than at the top. Part of this thick base rests on top of the bowl shell and part of it extends down inside the bowl shell.

The part of the bowl top extending down inside the bowl shell has an 0-ring retaining groove. An oil-resistant 0-ring installed in this groove forms a liquid-tight seal between the bowl top and the bowl shell. This seal ensures that the liquids involved in the purifying process will be confined to their normal flow through the bowl shell assembly.

A large coupling ring is threaded down over the base of the bowl top to the upper/outside edge of the bowl shell. This ring holds the bowl top in place.

A protruding rectangular tab on the underside of the outer rim of the bowl top engages a notch in the bowl shell to ensure rotation of the bowl top.

The top edge of the bowl top has a retaining groove into which is inserted an oil-resistant rubber seal ring. This ring is a flat rubber washer, not an 0-ring. A discharge ring seats on top of this seal ring.

The outer edge around the top of the bowl top is threaded to receive a coupling nut. The coupling nut screws down over the discharge ring, forcing the discharge ring down onto the rubber seal ring. This seal ensures that discharging water will flow up through the center of the discharge ring.

The coupling ring, as previously stated, forces the bowl top down onto the top of the bowl shell, thus completing a seal. As the coupling ring is screwed downward, it forces the bowl top down onto the disk stack. This action compresses the disk stack and ensures that each disk will seat tightly on its adjacent disks. The space between each disk is thereby assured to be correct.

To ensure correct tension on the disk stack, an aligning mark is stamped on the coupling ring and the bowl top. These two marks must be lined up when tightening the coupling ring. An indicating arrow and the word "OPEN' are also stamped on top of the coupling ring. These marks show the direction of rotation to remove the coupling ring.

CAUTION

The coupling ring and coupling nut have left-hand threads.

Four T-shaped slots are equally spaced around the outside/upper rim of the coupling ring. A special wrench engages these slots for removal or installation of the coupling ring.

A discharge ring, seated on top of the bowl top, acts as a dam to maintain the proper line of separation between the water and the JP-5 within the bowl shell assembly.

Each purifier is furnished with a set of seven discharge rings. The outside diameters of the discharge rings are the same. The inside diameters of the discharge rings are different. The inside diameter size is etched on each ring. The inside diameters range from 220 millimeters to 250 millimeters in 5-millimeter increments (220, 225, 230, 235, 240, 245, and 250).

The coupling nut locks the discharge ring in place. Like the coupling ring, the coupling nut also has an indicating arrow and the word "OPEN" stamped on its top.

The coupling nut has four circular slots equally spaced around its outer edge. A special wrench engages one of these slots for removal or installation.

Purifier Operations

The operations described in this section deal with starting from two different conditions-with a clean bowl and with a dirty bowl.

Regardless of the condition of the bowl, there are some preliminary steps to follow before starting the purifier. These steps are as follows:

1. Open the bowl cover.
2. Ensure the handbrake is in the OFF position.
3. Remove the two bowl shell lock screws.
4. Insert the two bowl shell lock screw plugs.
5. Turn the bowl by hand. If the bowl does not turn freely, investigate and correct the cause.
6. Check the level of oil in the oil sump. If the oil is at or below the red line, add sufficient oil to raise the oil level to the white line.
7. Close the bowl cover and engage and tighten the three handwheel cover clamps.
8. Engage the feed tube to the paring disk.
9. Ensure the seal water inlet hose is connected to the purifier seal water inlet valve.
10. Ensure the purifier sump tanks are empty.

The following starting and stopping procedures are for transferring fuel from one port wing storage tank, through one transfer pump, through the port purifier, to one port wing service tank. Since transfer is from wing tank to wing tank within the same group of tanks, and on the same side of the ship, there is very little change to the list and trim of the ship. The starboard service tanks can be filled from starboard storage tanks in the same manner. But, the transferring is accomplished by using only one transfer pump to pump into one purifier, since they both have the same capacity.

Starting with a clean bowl is accomplished as follows:

1. Close the following valves:
   a. Sample connections.
   b. Purifier inlet valve.
   c. Purifier discharge valve.
   d. Purifier seal water inlet valve.
2. Open the following valves:
   a. Designated manifold tankside valve.

b. Designated manifold transfer mainside valve.

c. Designated transfer-pump inlet valve.

d. Designated transfer-pump discharge valve.

e. Designated transfer-pump inlet and discharge gage valve.

f. Freshwater supply valve (seal water supply).

g. Bowl casing drain valve (locked open).

h. Designated service-tank fill valve.

i. Purifier discharge valve.

3. Start the purifier (press start button).

4. When the purifier bowl shell assembly attains 4,100 rpm (146 to 150 bumps per minute within 11 minutes), open the seal-water inlet valve.

5. Open the main water-discharge observation port on the cover assembly.

6. When water discharges past the observation port, close the seal-water inlet valve.

7. Start the designated transfer pump (press start button).

8. Slowly open the purifier inlet globe valve and throttle to maintain 9 psi inlet pressure. Then throttle the purifier discharge globe valve to maintain 30 psi back pressure.

9. Log the time the following were started:

a. Transfer pump.

b. Purifier.

CAUTION

Certain conditions will occur that will require the purifier to be left running for brief periods of time with no fuel flow. The purifier must then be placed in the standby mode to prevent overheating of internal parts.

NOTE

TO PLACE THE PURIFIER IN STANDBY MODE:

- Shut the purifier inlet valve.
- Stop the designated transfer pump (press stop button).
- Manually open the seal water valve to the purifier and admit a small flow (trickle) of seal water to the purifier.
- Check after 5 minutes and every 5 minutes thereafter to ensure the inlet-outlet housing and purifier bowl cover are cool to the touch.
- If the housing and cover are not cool to the touch, increase the flow of seal water.

10. While the purifier is running:

a. Log the designated transfer pump inlet and discharge gage readings.

b. Log the purifier inlet and discharge gage readings.

c. Take inlet and discharge samples:

(1) Analyze samples with the AEL Contaminated Fuel Detector Mk III.

(2) Log the results of the analysis.

11. When the designated transfer pump loses suction on the storage tank:

a. Close the purifier inlet valve.

b. Open the manifold valves for the next storage tank to be emptied.

c. Close the manifold valves for the already empty storage tank.

d. Repeat step 8.

12. When the service tanks are 95 percent full, stop the transfer operation. The procedure for stopping the purifier is as follows:

a. Close the purifier inlet valve.

b. Stop the designated transfer pump (press stop button).

c. Stop the purifier (press the stop button).

d. Do not engage the brake.

e. The purifier will coast to a stop (about 45 minutes).

f. As the purifier slows down:

(1) Centrifugal force diminishes.

(2) Feed inlet pressure will drop to zero.

(3) Discharge pressure will drop to zero.

g. Close the purifier discharge valve.

h. Close all valves still open.

i. Log the time the following were stopped:

(1) Designated transfer pump.

(2) Purifier.

j. Log the gross gallons removed from the storage tanks.

k. Log the net gallons transferred into the service tank.

Emergency stopping procedures are:

1. Press the purifier stop button.
2. Apply the hand brake (handle up).
3. Stop the transfer pump (press stop button).
4. Close the purifier discharge and inlet valves.

NOTE

Since the purifier discharge and inlet valves are closed in that order, JP-5 trapped in the purifier places an added resistance to rotation, thus helping to stop the purifier.

The procedure for starting the purifier with a dirty bowl is as follows:

1. Complete all the preliminary steps.
2. Complete steps 1, 2, and 3 as when starting with a clean bowl.
3. Open the purifier seal water inlet valve. The seal water flowing into the purifier keeps the bowl balanced as the purifier comes up to speed.
4. When the purifier attains full rpm, complete steps 5 through 12 as when starting with a clean bowl.

The position of the line of separation between the JP-5 and water is important to proper purification. For good purification, this line should be outside the disk stack but well under the top disk. If the line of separation is too far out, some or all of the JP-5 will dis-charge with the water. If the line of separation is too far in, water will discharge with the JP-5. The position of the line of separation depends upon the selection of the proper discharge ring. The discharge ring depends on the specific gravity of the JP-5. Once the specific gravity is determined, refer to the chart of discharge ring sizes (fig. 4-35).

Find the specific gravity number along the base of the chart. From this point, inscribe a vertical lineup the chart until it intersects with the solid curved reference

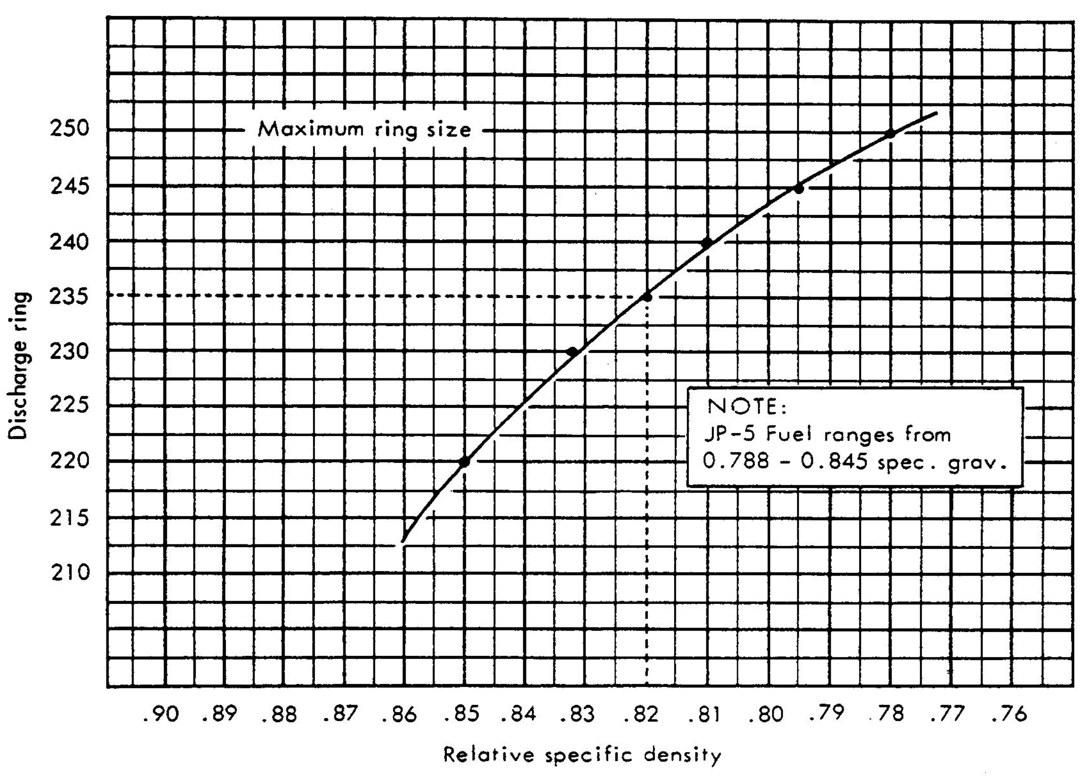


Figure 4-35.—Discharge ring size chart.

line. From the point of intersection, inscribe a horizontal line to the left-hand border of the chart. The numbers along the left-hand border do not exactly point to a ring number; always use the next smaller ring.

Install this ring in the purifier. Operate the purifier, and observe the JP-5 and water-discharge sight flow gages. If all of the discharge goes out the water discharge, the discharge ring is too large. Stop the purifier and install the next smaller ring. Make another trial. If necessary, repeat until JP-5 is properly discharged from the bowl shell assembly. If more than one trial is required, it generally indicates a mistake was made in determining the correct specific gravity or in using the discharge ring size chart.

CAUTION

When the seal water is cold, a small amount of JP-5 may discharge with the water at first. This will cease as the water, JP-5, and purifier heat up. In this case, it will not be necessary to change the discharge ring.

If water discharges with the JP-5, the discharge ring is too small; try the next larger ring.

When the proper size discharge ring is established, do not change it. As a general rule, the most satisfactory purification occurs when the discharge ring is the largest size possible without causing loss of JP-5.

During normal operations, there should be no more than a small discharge from the water outlet. The bulk of the discharge should be out the purifier JP-5 outlet.

If a large discharge from the water outlet is observed, it indicates excessive water in the feed, or the water seal has been lost. The operator should immediately determine whether the excessive discharge is water or JP-5.

If the excessive discharge is JP-5, the bowl has lost its seal. Stop the flow of feed; reprime the bowl; and slowly resume the flow of feed.

If the seal is again lost, immediately stop the purifier and check the discharge ring size and the bowl shell assembly's two robber seal rings. Correct the cause and resume operation.

If the excessive discharge is water, secure the operation and determine the source of the water. Sound the storage tanks with water-detecting paste and restrip the storage tanks as necessary.

NOTE

If the tanks have been properly settled and stripped, there should never be more than a trace of water in the feed.

If water has been put into the service tanks, they must also be stripped. If no water is found in the storage tanks, check the piping in the bilge, voids, etc., for leaks or other possible sources of water.

Purifier Maintenance

Establish and maintain a regular cleaning schedule, considering the following factors:

1. Accumulation of a large quantity of heavy solids in the bowl shell will cause the bowl to run rough. The bowl must be cleaned before the wet cake exceeds 30 pounds or 1 1/2-inch thickness at its thickest point.

2. If the purifier is to be inactive for less than 12 hours, it must be flushed out with freshwater while it is still operating, by using the priming water.

3. If the purifier is to be inactive longer than 12 hours, it must be disassembled and thoroughly cleaned.

4. In any event, the bowl must be disassembled and thoroughly cleaned at least once a week.

The purifier bowl should be inspected for corrosive pitting. If pitting is found, the bowl should be thoroughly cleaned with a mild abrasive cleaner in combination with stainless steel sponges. If pitting continues, the bowl should be reconditioned at the earliest opportunity.

Where pitting has progressed to 1/4-inch in depth, replace the bowl.

CAUTION

Continued use of deeply pitted bowls can be potentially hazardous.

When disassembling and assembling the bowl shell assembly for cleaning, you must remember that the parts are heavy. For this reason, a chain hoist and trolley have been provided to lift the parts and transport them to a deep sink. Be careful when raising, lowering, and transporting the parts. It is imperative that the chain hoist be centered directly over the center of the spindle before any part is raised or lowered.

To disassemble the purifier for cleaning, proceed as follows:

1. After stopping the bowl, remove the plugs and insert the lock screws. The two lock screws (one on each side of the purifier) enter the slots in the bowl shell, locking it in position.

2. Using the spring-loaded tee handle on top, unscrew the feed tube until it is free from the paring disk.

3. Loosen the three handwheel cover clamps and swing the bowl casing cover back until it engages the ratchet hook. This will automatically lock the cover in the open position.

4. Unscrew the bowl top coupling nut (fig. 4-36), using the special tool (inset, fig. 4-36) and remove the discharge ring and rubber ring.

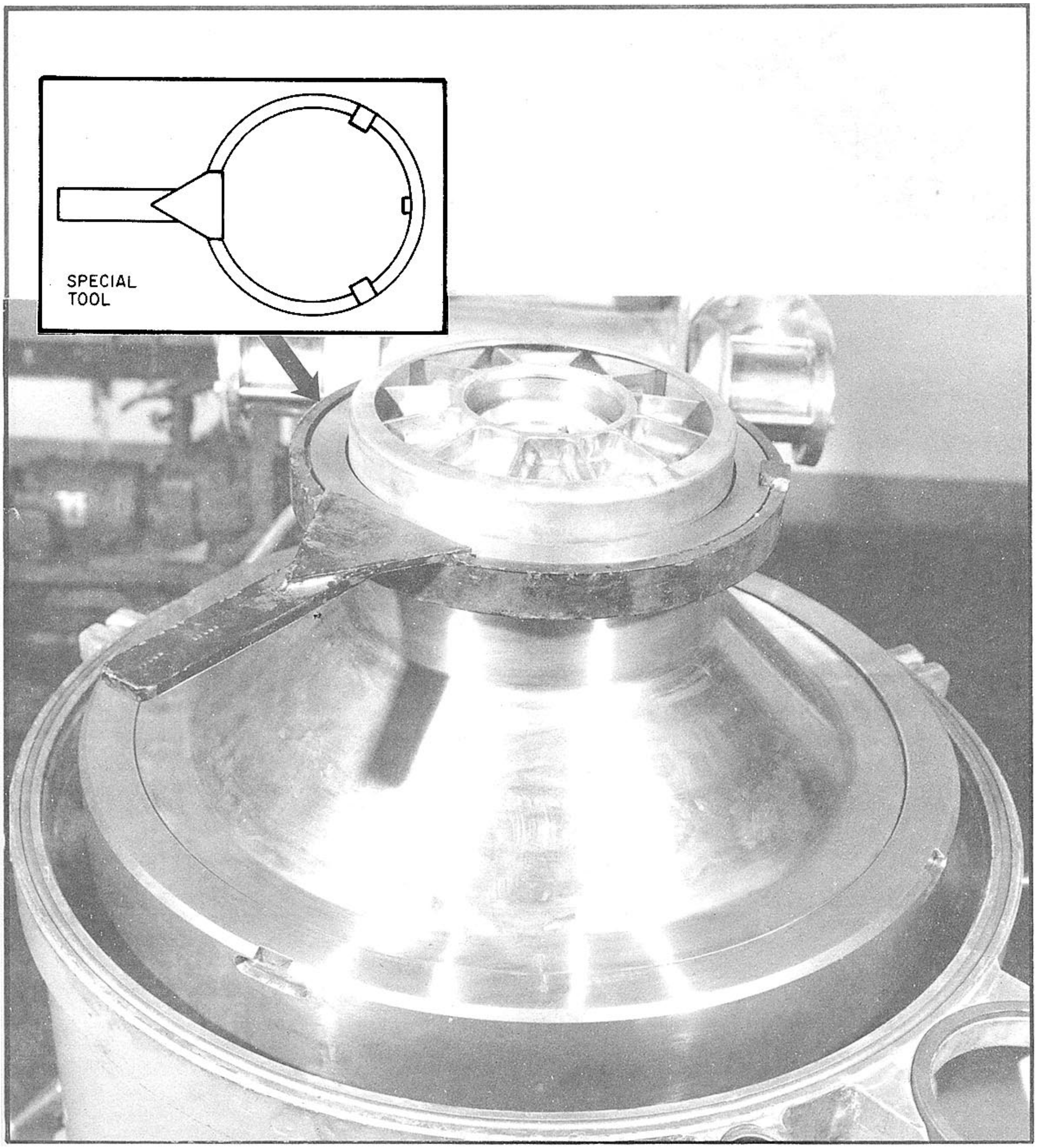


Figure 4-36.—Removing bowl top coupling nut (with special tool).

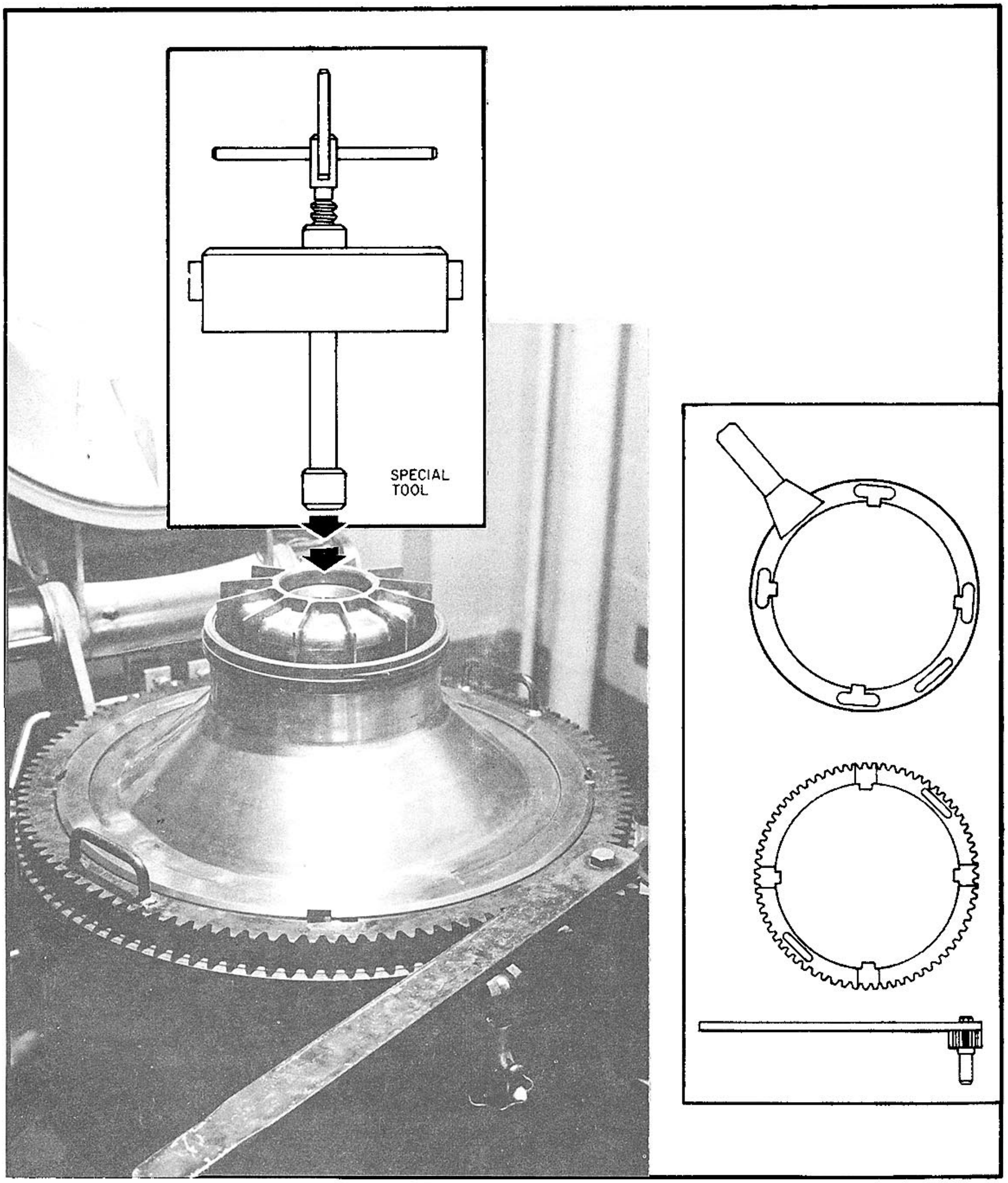


Figure 4-37.—Removing coupling ring (with special tool).

5. Remove the coupling ring (fig. 4-37) by loosening it first with the gear wrench, then unscrewing the coupling ring with the special tool.

6. After removing the coupling ring, screw the lifter into the bowl top. When you turn in on the T-handle jackscrew on top of the lifter, the bowl top will let loose from the bowl shell. Using the chain hoist, lift the bowl top off, being careful with the rubber ring. Remove the rubber bowl ring and lay it flat.

7. Remove the tubular shaft, top disk, paring disk, and intermediate disks, with the chain hoist, using the special tool provided. (See figure 4-38.)

8. If removal of the bowl is required, lift out the bowl strainer. Remove the spindle cap nut and back out

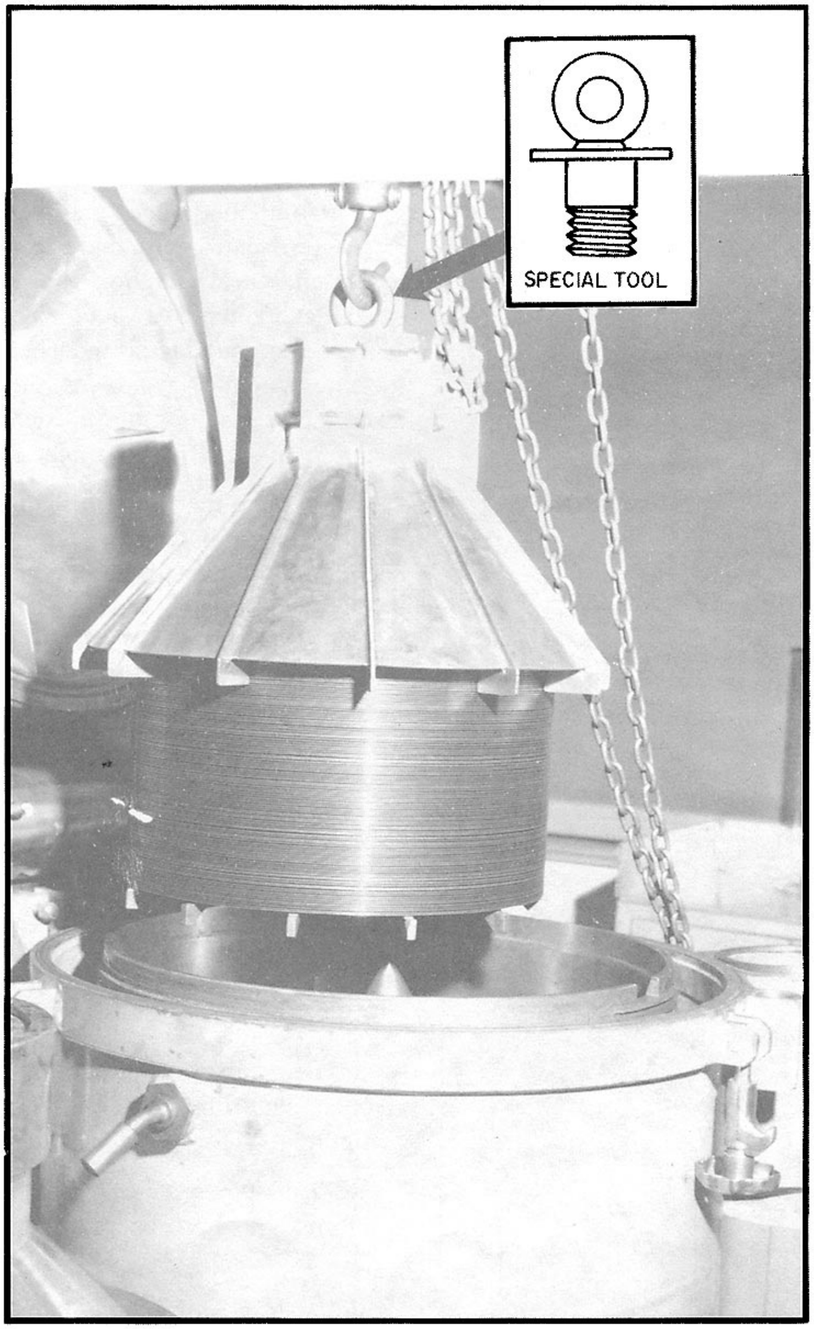


Figure 4-38.—Removing disk stack.

both lock screws. Screw the lifter (fig. 4-39) onto the bowl shell, and by turning in on the jackscrew the shell will loosen from the spindle. Using the chain hoist, lift the shell from the frame.

After the bowl parts have been disassembled, remove the rubber rings and clean the tubular shaft and disks with a brush, using JP-5 as the cleaning fluid. Reassemble in the reverse order.

0-rings and gaskets should never be hung vertically; lay them neatly on a clean, flat surface. Hanging will seriously distort the shape of 0-rings and gaskets. When installing 0-rings, always inspect them for nicks, cuts. or abrasions; use only good 0-rings. Examine the 0-ring retaining slots and other contact surfaces for nicks and burrs, and remove such before installing the ring. Make sure that the retaining slot and contact surface are clean, and coat the 0-ring with a light machine oil before installation.

Maintain the lubrication system in a perfect condition. Refer to the manufacturer's instruction manual and current Instructions about the type and amount of lubricant.

PRESSURE GAGES

Pressure gages are used throughout the AvFuels system to measure and indicate pressure so the operator of the equipment can maintain pressure at safe and efficient operating levels. A wrong pressure indication is often the first sign of trouble with the equipment. Any excess or deficiency in pressure should be immediately investigated.

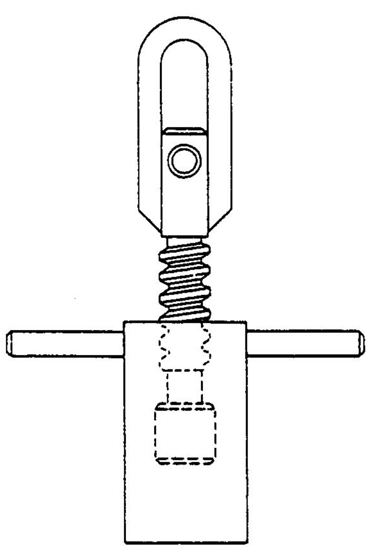


Figure 4-39.—Bowl shell lifter.

There are three types of gages the ABF will typically use in operating the AvFuels system: Simplex pressure gages, compound gages; and differential pressure gages.

Simplex pressure gages measure pressure only. The gage readings range from zero to the gage's maximum rated pressure. A Simplex pressure gage has two pointers: One, usually black or white, indicates the actual operating pressure of the system the gage is attached to; the other, usually red, is manually positioned to indicate the normal operating pressure of the system the gage is attached to. These gages are normally installed on the discharge side of pumps.

Compound gages are nearly identical to simplex pressure gages, with one exception. Compound gages can measure vacuum. The gage readings typically start at 30 inches of vacuum and increase to the gage's maximum rated pressure. The pointers are exactly the same as on the simplex pressure gage. These gages are normally installed on the suction side of pumps and the main deck filling connections.

Differential pressure gages are used to measure the pressure between two pressure lines. A differential pressure gage has only one pointer and does NOT measure actual pressure. It measures the pressure DIFFERENTIAL between two pressure sources. These gages are normally installed on vertical and reclaim filters.

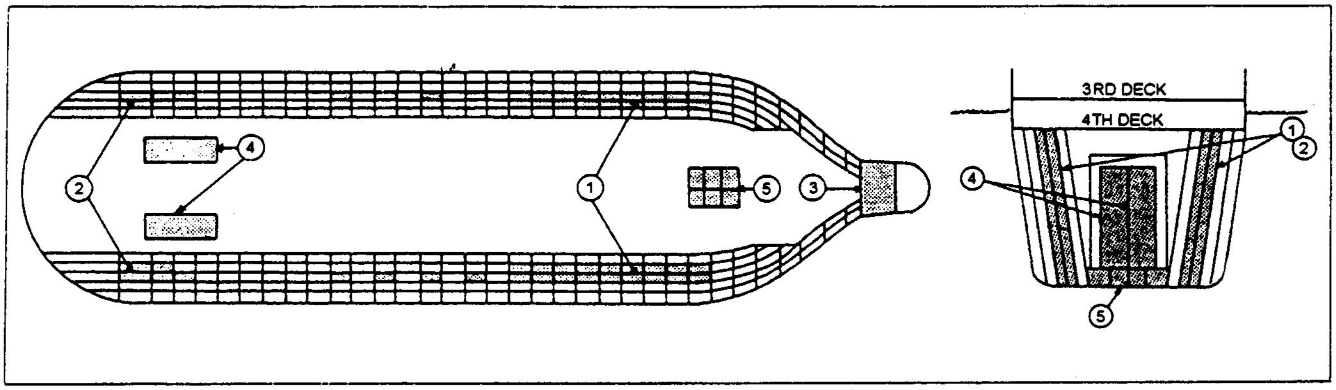
TANKS

Storage of aviation fuel aboard carriers has always presented a serious fire and explosion hazard. With the introduction of JP-5 as the primary jet fuel, hazards in handling were lessened and, because of the high flash point of JP-5 (minimum 140°F), protective storage is not required.

Basically, there are four types of JP-5 tanks: wing, deep centerline, double-bottom, and peak tanks. See figure 4-40 for the types and locations of JP-5 tanks.

Tank types generally relate to the relative location of the tanks in respect to the hull of the ship.

Wing tanks are deep tanks located in a forward and aft row along the contour of the hull on the port and starboard sides of the ship. There are normally two rows of wing tanks on each side. These tanks are located between voids and are an integral part of the ship's underwater protective system. The top of the



1 JP-5 wing tanks (forward group)
2. JP-5 wing tanks (after group)
3. Peak tanks
4. Deep centerline tanks
5. Double-bottom tanks

Figure 4-40.—Types of JP-5 tanks.

tank is at the fourth deck level, and the bottom is the shell of the ship. There are an equal number of port and starboard wing tanks in the forward group and in the after group. Each port tank has an identical twin of the same shape and capacity located directly opposite on the starboard side. These twins are operated as a unit; that is, they are filled and emptied as if they were one tank, to preserve the list and trim of the ship.

Deep centerline tanks referred to here were the original AvGas tanks on CVs that were converted to JP-5 tanks. Normally, all forward tanks and the after port tanks were converted. The cofferdams for the converted tanks are either filled with fresh water or used as service or storage tanks.

Seagoing vessels have two bottoms: a bottom and an inner bottom. The space between double bottoms is divided into many watertight compartments, which are used for storage of fuel, water, or ballast. These are called double-bottom tanks. The bottom of these tanks is the bottom or outer shell of the ship. The top of these tanks is the inner bottom, which is also the deck of the bilge. Double-bottom tanks are, by necessity, shallow tanks.

Peak tanks are deep tanks, which are located in the extreme bow and stem of the ship below the waterline. Only the bow tanks are used for JP-5 storage presently. The shell of the ship forms two sides and the bottom of each peak tank.

Fuel tanks, like all compartments aboard ship, are numbered to identify their location. Each tank has its own number. The first number indicates the deck level, the second indicates the frame, and the third indicates the tank's position in relation to the ship's centerline. Knowing the location of the tanks is a tremendous asset in learning your ship's fuel system. It will also help you locate the sounding caps for each tank's sounding tube. Generally, the cap will be one or two decks directly above the tank it serves. Every sounding cap is marked with its tank number. Sounding caps are X-ray fittings and must be replaced tightly after each use.

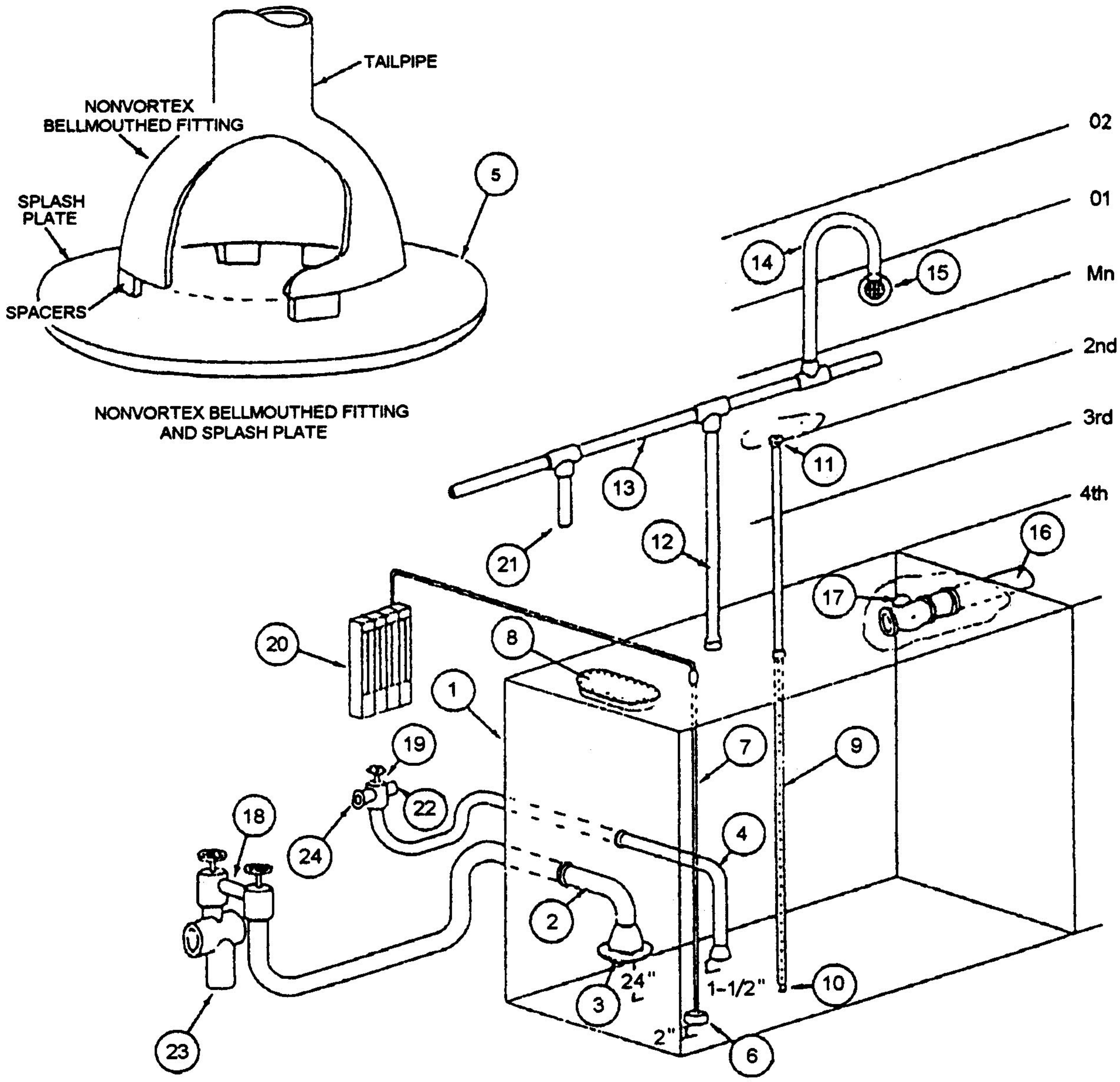
JP-5 tanks are designed and constructed to fulfill specific purposes and are classified under two major categories: STORAGE and SERVICE.

A *storage tank* is any tank used for the bulk storage of JP-5. Any wing, deep centerline, double-bottom, or peak tank can be used for bulk storage. A service tank is any tank used for storage of JP-5 suitable for issue to aircraft. The JP-5 in a service tank has been passed through either a filter or a centrifugal purifier before being pumped into the *service tank*. Generally, only wing or deep centerline tanks are used for this purpose. Service tanks have but one purpose: servicing aircraft. But storage tanks can be used for several purposes. The designation of each tank indicates purpose of that tank.

JP-5 Storage Tanks

A typical JP-5 storage tank with associated piping is shown in figure 4-41. Each JP-5 storage tank and the piping within the tank are sandblasted

is shown in figure 4-41. Each JP-5 storage tank and the piping within the tank are sandblasted to bare metal and coated with a protective coating to minimize rust formations. An air escape riser that vents the tank to the atmosphere extends from the top of the tank to an air escape



1. Tank
2. Fill and suction tailpipe
3. Nonvortex bellmouthed fitting and splash plate
4. Stripping tailpipe
5. Nonvortex bellmouthed fitting
6. Magnet-equipped float
7. TLI transmitter
8. Manhole
9. Sounding tube
10. Striker plate
11. Sounding tube cap
12. Air escape riser manifold)
13. Air escape main
14. Air vent
15. Flame arrester
16. Overflow line
17. One-way check valve
18. Suction and fill manifold (double or single-valved
19. Stripping manifold
20. TLI receiver
21. Connection to other tank air escape risers
22. Connection to other tank valves
23. Connection to transfer main branch header
24. Connection to flood and drain manifold

Figure 4-41.—Typical JP-5 storage tank.

The air escape riser (vent line) prevents a buildup of pressure when the tanks are being filled and prevents a vacuum from forming when the tanks are being emptied.

There are usually four air escape mains serving the forward and after groups of tanks: two forward (one port and one starboard) and two aft (one port and one starboard). A cane-shaped vent line extends up from each main to just below the 02 level and loops back down to just below the 01 level, where it terminates in scan. One end of the can, which contains a flame arrester, penetrates the skin of the ship and is open to the atmosphere. The outboard end is covered with a ratproof screen, and the inboard end is closed by an inspection plate. The flame arrester is cleaned quarterly.

CAUTION

The ship's side cleaners should be cautioned about spray painting near these vents. Sprayed paint can stop the flow of air through the vents by clogging the flame arrester.

An overflow line extends from near the top of the storage tank to an overflow tank. This line is considerably larger than the tank fill line to prevent rupture of the storage tank in the event of overfilling at high pressure. When the tank is full, it will overflow via a one-way check valve into the overflow tank for that nest of tanks.

NOTE

A *nest of tanks* is that small unit of tanks within a group of tanks that is serviced by one overflow tank. The forward and after groups of storage tanks consist of several nests of tanks.

A bolted manhole cover provides access to the tank for inspection, cleaning, and maintenance. A sounding tube extends from the extreme bottom of the tank to the second or third deck. The lower end is secured to a striker plate, and the upper end is closed by a threaded access cap. That section of the sounding tube within the tank has evenly spaced holes to ensure that the level of fuel in the tube is the same as that in the tank. Sounding tubes are provided for measuring the quantity of JP-5 in the tank, detecting water, and thieving a sample.

The suction and fill tailpipe extends from the manifold to terminate between 6 to 24 inches off the bottom at the lowest end of the tank. A nonvortex bellmouthed fitting and a splash plate are installed on the end of the tailpipe. This fitting reduces turbulence when filling, prevents a vortex from forming when emptying the tank, and prevents taking a suction directly off the bottom. Storage tanks are filled and emptied through this line.

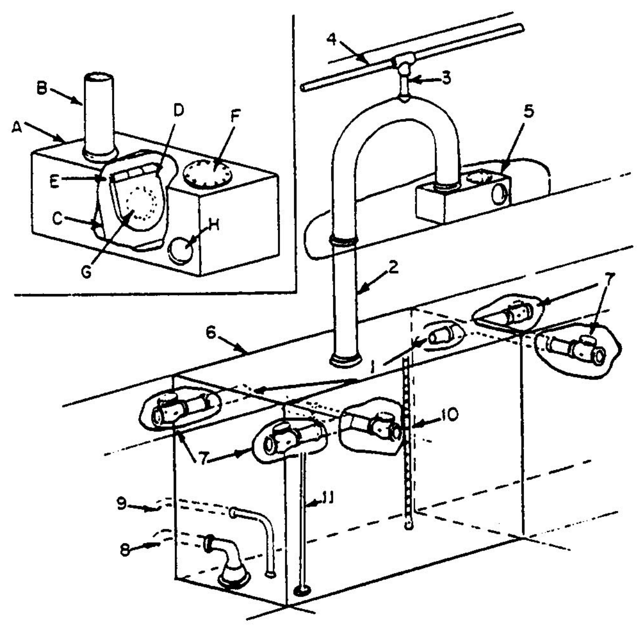
The stripping tailpipe is similar in design to the suction and fill tailpipe except it is smaller and has no splash plate. This line extends from the stripping manifold to a maximum of 1 1/2 inches off the bottom at the lowest end of the tank. The stripping tailpipe is used to remove water and sludge from the bottom of the tank and to completely empty the tank by removing the last 24 inches of usable JP-5 when consolidating the fuel load. The stripping tailpipe is also used when ballasting and deballasting the storage tanks.

NOTE

JP-5 storage tanks have a filling rate of 500 gpm per tank, with the required minimum of six tanks on the line.

JP-5 Overflow Tanks

Overflow tanks (fig. 4-42) have the same fittings previously described for the storage tanks, except for



A. Overflow box
B. Overflow line
C. Dividing bulkhead
D. Flapper check valve
E. Hinge
F. Access cover
G. Hole through dividing bulkhead
H. Hole through ship's skin
1. Overflow from storage tanks in the nest
2. Overflow line
3. Air escape riser
4. Air escape main
5. Overflow box
6. Overflow tank
7. One-way check valves
8. Fill and suction tailpipe with nonvortex fitting
9. Stripping tailpipe
10. Sounding tube
11. TLI transmitter

Figure 4-42.—Typical JP-5 overflow tank.

the large overflow line and the arrangement of the vent line. In addition to serving as a regular storage tank, they are also designed to receive the overflow from the other storage tanks in their respective nest.

The overflow tanks are actually a safety feature to prevent rupturing of storage tanks if they are over-pressurized during a filling operation. The overflow tanks overflow overboard when they are full. The large overflow line extends up from the top of the tank to just below the second deck. Here it loops back down and discharges into an overflow box on the third deck. The overflow box contains a flapper check valve that allows JP-5 to be discharged overboard but prevents seawater from entering the tanks. An inspection plate located directly over the valve allows access for cleaning and maintenance. In the past, flapper check valves have frozen open due to corrosion, and seawater contamination of JP-5 has resulted. These valves must. therefore, be inspected at least every 6 months (more often if necessary).

The overflow tanks are vented via an air escape riser from the top of the loop in the overflow line to one of the common air escape mains. Overflow tanks are the last tanks to be filled when receiving JP-5 aboard and are the first tanks to be emptied when transferring internally.

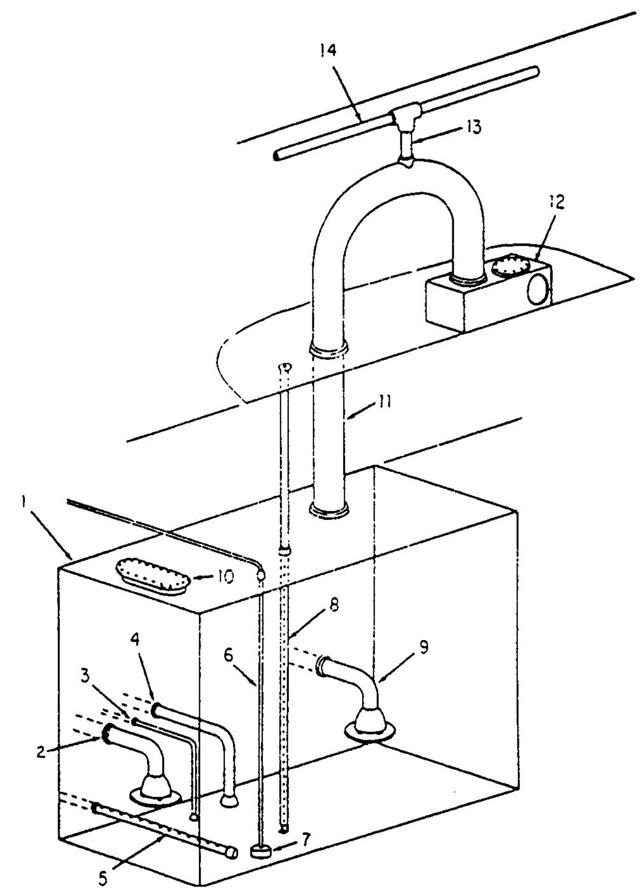
Contaminated-JP-5 Settling Tanks

The contaminated-JP-5 settling tanks are designated tanks that receive JP-5 from hose flushings, defuels, tank stripping operations, and the initial flow during a refueling at sea. In addition to standard piping, these tanks have piping branching from the defuel mains. Each branch of defuel piping going into a contaminated settling tank must terminate about 48 inches above the bottom of the tank, with a perforated horizontal run about 24 inches long to reduce turbulence.

After stripping, JP-5 transferred from these tanks will be transferred via a JP-5 reclamation prefilter and JP-5 reclamation filter/separator, in that order, to the storage tank manifold of the selected storage tank to be filled.

JP-5 Service Tanks

Although much of the equipment in the service tanks (fig. 4-43) is similar to that described in the storage and overflow tanks, the piping arrangement is different and additional equipment is required.



1. Service tank
2. Filling tailpipe with nonvortex fitting
3. Hand pump stripping tailpipe
4. Motor-driven stripping tailpipe
5. Horizontal recirculating line
6. TLI transmitter
7. Magnet-equipped float
8. Sounding tube
9. Suction tailpipe with nonvortex fitting
10. Manhole
11. Overflow line
12. Overflow box
13. Air escape riser
14. Air escape main

Figure 4-43.—Typical JP-5 service tank.

Service tanks have an independent filling tailpipe and an independent suction tailpipe. The filling tailpipe branches from the service tank fill line header in the JP-5 pump room to terminate in a non-vortex bellmouth fitting between 6 to 24-inches off the tank bottom. Additionally, the termination height will beat least 3 inches lower than the suction tailpipe. Service tanks are NEVER filled directly from a tanker, barge, or pier. They are always filled from settled storage tanks, via the centrifugal purifiers.

The suction tailpipe extends from the service pumps common suction header to terminate in a non-vortex bellmouth fitting either 12 or 24-inches off the tank bottom in the opposite end from the fill line.

NOTE

Height of termination above tank bottoms for service tank suction tailpipes for CV/CVNs, LHAs, and LPHs is 24 inches for wing tanks and 12 inches for innerbottom tanks. For other ships, the height is 12 inches.

A shut-off valve is installed in this line between the service pump common suction header and the service tank.

Two independent stripping systems, one hand-operated and the other motor-driven, are installed in each service tank. The hand operated stripping is used for normal stripping of the service tanks. The use of the low velocity hand operated pump eliminates turbulence in the tank while stripping, which improves the efficiency of the stripping operation. The tailpipe for the hand operated stripping pump extends from a maximum of 3/4-inch off the service tank bottom to the hand operated pump in the pump room.

The motor-driven stripping system for service tanks is primarily used to completely empty the tanks and to remove the wash water after a cleaning operation. The tailpipe for the motor-driven stripping pump extends from a maximum of 1 1/2-inches off the tank bottom to the common suction header of the motor-driven stripping pumps. This line contains a shutoff valve, a one-way check valve, and a blank flange.

A recirculating line is installed horizontally 18-inches off the tank bottom in the opposite end from the suction tailpipe. This line provides a means of returning to the service tank the recirculated fuel from the discharge side of the service pump. A number of 1-inch holes, equally spaced along the top of the recirculating line allow JP-5 to be returned to the tank without disturbing the contents of the tank. Foaming is minimized since the recirculating line is always covered with JP-5.

Tank Inspection and Cleaning

WARNING

No person is to enter any JP-5 tank for inspection or cleaning until the conditions for safe entry specified by the Gas-Free Engineer (or his authorized representative) have been strictly complied with.

If the inspection reveals that bulkheads, stiffeners, and flat surfaces have collected solids that are readily visible, storage tanks are washed with sea water from a firehose. Service tanks are normally just wiped clean, but if washing is required, use fresh water only. Wash water is removed from storage tanks designated JP-5 or ballast by the main drainage eductor, and from service tanks and storage tanks (designated JP-5 only) by the JP-5 motor-driven stripping pumps.

The above procedures are followed if the operation is conducted at sea. If conducted in port, assistance by a shore activity and changes in the wash water removal procedure are required to prevent harbor pollution.

Due to the ease with which deposits can be washed out of JP-5 tanks with a firehose, steaming is not required nor should it be employed since the tank coatings may be damaged.

JP-5 tanks are never cleaned by the chemical cleaning processes using solvent-emulsifier type compounds. Small quantities of chemical type cleaners remaining in the tanks will contaminate the coalescer elements in the filter/separator and destroy their coalescing ability.

When conducting the inspection and cleaning of JP-5 tanks, refer to applicable Maintenance Requirements Cards for correct procedures and safety precautions to be followed.

GEMS TANK LEVEL INDICATING (TLI) SYSTEM

The Gems TLI system (fig. 4-44) consists of a transmitter, jumper cables, receiver, and a magnet-equipped float.

The transmitter is mounted vertically within the tank by brackets or flanges. A voltage divider network is located inside and extends the full length of the transmitter assembly. This network is comprised of magnetic reed switches tapped in at one-inch intervals between the switch centers. The switches are connected, in turn, through series resistances, to a common conductor, and by means of the cable system to the indicating meter in the receiver. The ends of the voltage divider are connected to the power supply output. The power supply output is adjusted to 10 volts dc by the calibrate potentiometer in the primary receiver.

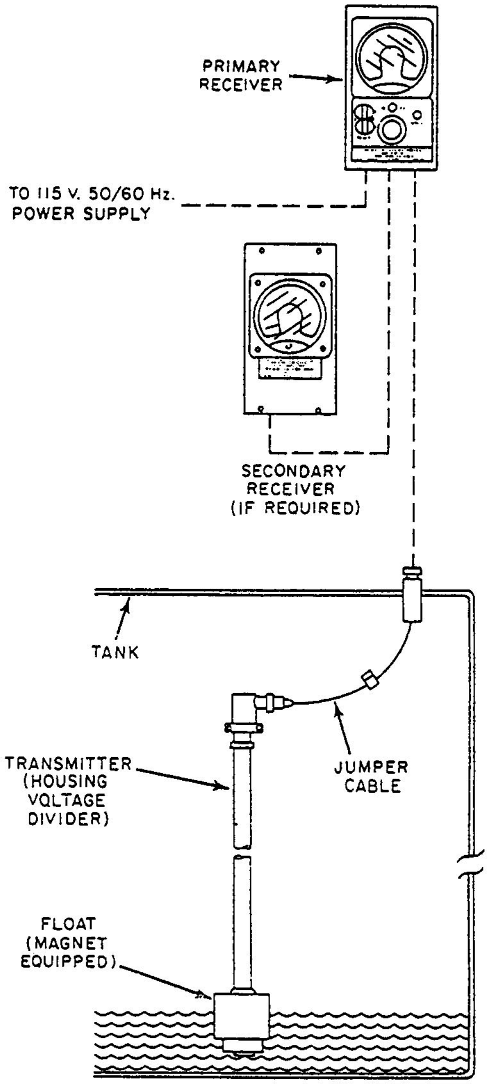


Figure 4-44.—Gems TLI system.

Depending on the size and shape of the tank being gaged, the transmitter assembly may be a single unit, or a number of units connected together. Figure 4-45 shows two transmitters being used to gage a tank.

The magnet-equipped float moves along the transmitter as the liquid level changes. As the float moves. the magnetic field pattern of the float operates the tap switches. The tap switches are so arranged inside the transmitter that voltage drops are read at the receiver for each 1/2-inch of float travel.

The primary receiver is connected to the transmitter by the cable system. Since the receiver meter indicates the voltage drop from the bottom of the voltage divider to the point of tap switch closure, the readings correspond directly with the liquid level. Included in the primary receiver housing, in addition to the indicating meter, are the dc power supply, electrical slosh dampening control, and all system and alarm controls.

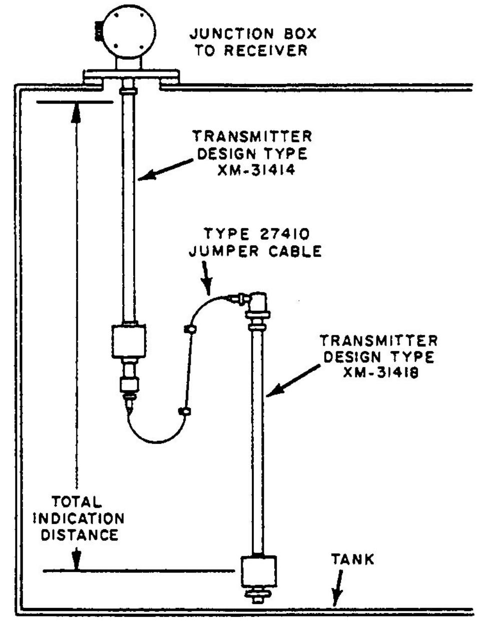


Figure 4-45.—Multitransmitter arrangement.

See figure 4-46 for the various types of primary and secondary receivers.

The primary receiver also provides for connection of one or more secondary receivers. The secondary receiver, if used, contains an indication meter only.

The system is safe, since currents in the transmitter circuit are so low as to be incapable of causing an explosion, even with the transmitter located in the most volatile liquids or hazardous vapors.

CAUTION

The transmitter or receiver should NOT be tampered with or modified in any way other than as directed in the operation and maintenance manual.

The following is a brief description of the system controls.

ON-OFF-FULL REF. TOGGLE SWITCH: Operates as follows to control the ac input to the power supply and the indicating meter circuit:

Toggle in ON position (normal operation): 115 volt, 50/60 Hz applied to the power supply. Indicating voltmeter connected through series resistance to the transmitter tap switches.

Toggle in OFF position: Power supply line and indicating meter circuits are open. System is off.

Toggle in FULL REF. position (must be held in this position): ac line voltage is applied to power supply. Indicating meter is connected across entire transmitter voltage divider and cabling for system calibration.

CALIBRATE POTENTIOMETER. Screwdriver adjusted, with toggle switch held at FULL REF. position, it is adjusted to provide 10 volts dc across the entire transmitter, voltage divider, and cabling, as indicated by a full-scale meter reading. With the potentiometer properly adjusted. when the toggle switch is placed in the FULL REF. position, a full-scale meter reading indicates that all cables and electrical connections are good.

ELECTRICAL SLOSH DAMPENER. To prevent meter fluctuation as a result of erratic float

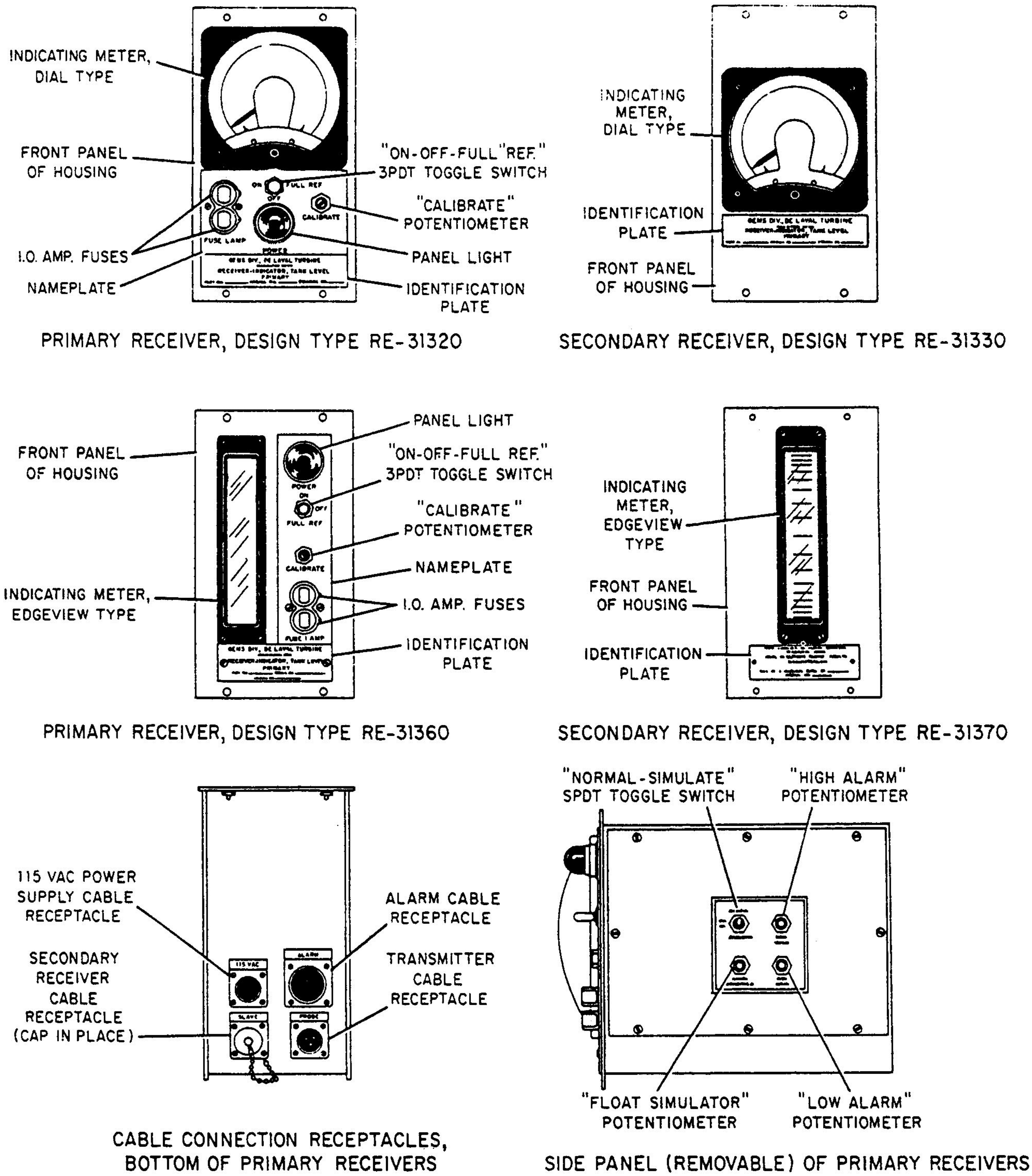


Figure 4-46.—Primary and secondary receivers.

movement caused by sloshing in the tank, a capacitor is connected across the indicating meter to delay the response (normally 3/4 second) of the meter to the transmitter signal.

ALARM CONTROL SYSTEMS. Known as a SENS-PAK alarm, its controls function integrally with the tank level indication system to sense high, low, or intermediate levels of tank liquids (as appropriate) and actuates an alarm. The modular, plug-in SENS-PAK units (fig. 4-47) are actuated by voltage signals from the indicating system transmitter. These units may or may not be included in the primary receivers.

Although all primary receivers are prewired for a maximum of two SENS-PAK units, normally used for high and low level alarms, additional control units may be incorporated in separate housings within the same system on advice from the factory.

SENS-PAK alarm control adjustments are located on the side of the receiver (refer to figure 4-46 [side panel]) and function as follows:

Normal simulate switch—Substitutes the float simulator circuit for the transmitter in the indicating meter circuit for alarm adjustment.

Float simulator potentiometer—Simulates the total transmitter voltage divider resistance change over the full range of float travel.

High alarm potentiometer—Sets the actuation voltage level of the high alarm SENS PAK.

Low alarm potentiometer—Sets the actuation voltage level of the low alarm SENS PAK.

This system surpasses the 3% accuracy requirement of military specifications. But, the accuracy will vary depending on the size tank being gaged and the type receiver used.

NOTE

The Gems TLI systems are also approved for indicating the interface level of two liquids having different specific gravities.

With the ON-OFF-FULL REF. toggle switch on the primary receiver in the ON position, operation of the system, and alarms if included, is completely automatic. Tank liquid level is read directly from the indicating meter on the primary or secondary receiver as required. No further attention is necessary, as the Gems TLI system can operate indefinitely without any component degradation.

The only maintenance that should be required is cleaning of the transmitter and float when tanks are opened for inspection and cleaning.

CONSOLES

The control console ushered in the modem era for the ABF. It provides us with the ability to control and monitor nearly all operations from one central location. While the console relieves you of a lot of footwork, it requires an in-depth knowledge of your ship's systems and capabilities.

Each console (fig. 4-48) consists of a control panel with a mimic diagram, various selector

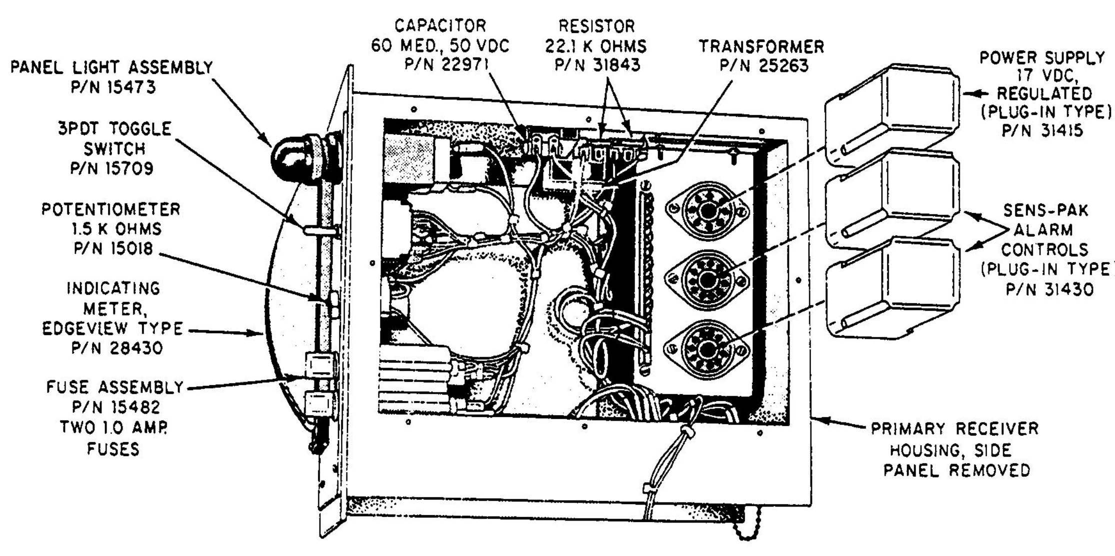


Figure 4-47.—Primary receiver interior.

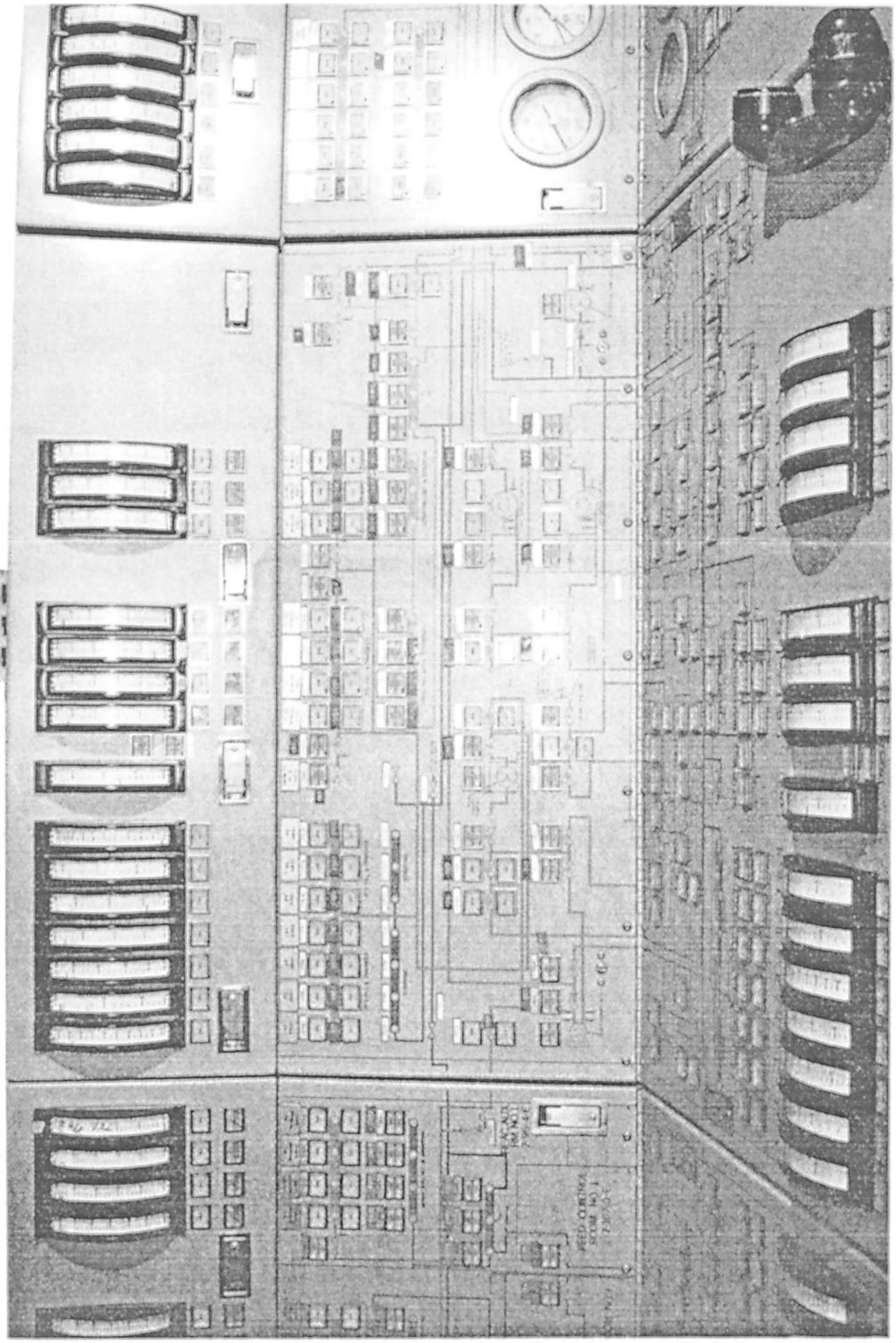


Figure 4-48.—Control Console.

switches, alarms and indicators. Specifically each console contains the following:

1. A **mimic diagram** colored to indicate JP-5 (purple), drainage (green), stripping (red), and miscellaneous (black) systems operated and/or monitored from the control console. The mimic also indicates the outline of the ship and shows components in their relative locations. Monitoring and control devices appear near or in the symbol served. The mimic on each console shows only the system served by the adjacent pump room except the filling and transfer mains; the filling system on 2nd and main deck are shown on both consoles. The drainage and ballast system shown is the part that serves the JP-5 or ballast and JP-5 over-flow or ballast tanks.

2. **Liquid-level indicators** for the JP-5, JP-5 or ballast, JP-5 overflow or ballast, JP-5 service, JP-5 defueling and contaminated-JP-5 settling tanks.

3. **"Full"-indieator (red) lights** for each tank. These lights are located adjacent the level indicator and are on when the tank reaches its operating capacity.

4. **Seawater-detector (green) lights** for JP-5 or ballast and JP-5 overflow or ballast tanks. These lights are located adjacent the level indicator and are on when seawater is present within the tank. These tanks also have white lights, which indicate the presence of JP-5 within the tank.

5. **Control switches** for starting and stopping the JP-5 service pumps.

6. **Indicator lights for valve positions** (open/-**shut)** for all motor operated valves and other valves (manually operated) whose position must be monitored at the console.

7. **Power indicator lights** for JP-5 purifiers and pumps (except auxiliary JP-5, jet engine test facility, JP-5 defuel pumps).

8. **Audible and visible overflow alarms** that warn when any tank having an independent overflow that overflows overboard reaches the 98 percent full level. A control switch is provided to silence the audible alarm.

9. **Seawater cleavage indicator lights** for contaminated-JP-5 settling tanks. The lights come on successively when seawater in the tanks reaches the 6-inch, 2-foot, 4-foot and 6-foot levels.

10. **Control switches** (open/shut) for positioning the selected electric motor operated valves.

11. **Override switches** that reenergize the circuit that closes tank cutout valves when the tank reaches operating capacity. This allows complete tank filling when desired. One switch controls a specific zone.

12. **Pressure gages** for firemain water to eductors and eductor suctions. These are the eductors used to deballast JP-5 or ballast and JP-5 overflow or ballast tanks.

Circuit Description

You might ask why an ABF needs to know the control circuits of a JP-5 console. We are operators of the console, not electrical repair personnel. In one respect, you are right, we do no repair work on the consoles. But you need to know how the circuits are interconnected to prevent specific things from happening, such as a storage tank valve that will not open because a saltwater level light is on for that tank.

Each console includes circuit operations as follows:

1. Circuit for JP-5 or ballast tank and JP-5 overflow or ballast manifold valve interlocked with manifold root valve. This circuit actuates the manifold valve either open or shut by a switch on the control console. Additional features of this circuit are:

a. Circuit automatically shuts manifold by high level detector circuit.

b. Circuit interlocks the root valve operation with the manifold valve. The root valve opens when any manifold valve is opened. The root valve closes when all manifold valves are closed.

c. Circuit does not allow manifold valve to open if sea water detector circuit indicates water in the tank.

d. Circuit monitors valve positions by open and shut lights on control console.

2. Circuit for JP-5 service tank suction and recirculating valves. This circuit actuates the suction valve either open or shut by a switch on the control console. The circuit interlocks the recirculating valve with the tank suction valve for the same tank so both valves open and shut simultaneously, circuit monitors valve position by open and shut lights on control console.

3. Circuit for JP-5 tank and JP-5 service tank fill manifold and gate valves. This circuit actuates the valves either open or shut by a switch on the control console. Circuit automatically shuts the valve by a high

level detector circuit and monitors the valve position by open and shut lights on the control console.

4. Circuit for drainage eductor actuating and overboard discharge valves. This circuit actuates the valves either open or shut by switches on the control console. Additional features of this circuit are:

a. The circuit stops the actuating valve in any intermediate position to allow throttling of eductors actuating supply.

b. Actuating valve is interlocked with the overboard discharge valve to prevent opening until the overboard discharge valve is opened.

c. The overboard discharge valve is interlocked with the actuating valve to prevent closing until the actuating valve is closed.

d. Circuit monitors valve position by open and shut lights on the control console.

5. Circuit for stripping, ballast, and drainage valves in the drainage system three-valve interlocked manifold. These circuits actuate the valves either open or shut by switches on the control console. Additional features of the circuits are as follows:

a. The three circuits are interlocked together to permit opening only one valve at a time. If any one of the three valves are open the other two are held closed by the circuits.

b. Stripping valve circuit bypasses the saltwater detector circuit to allow the JP-5 or ballast storage tank drainage manifold valves to be opened.

c. Circuit monitors valve positions via open and shut lights on control console.

6. Circuit for JP-5 and JP-5 service tank electric motor operated stripping manifold valve. This circuit actuates the valve either open or shut by a switch on the control console. Circuit monitors valve positions by open and shut lights on control console.

7. Circuit for JP-5 or ballast and JP-5 overflow or ballast tank drainage electric motor-operated manifold valves. This circuit actuates the valves either open or shut by a toggle switch on the control console. This circuit is interlocked with the seawater detector in the tank to prevent opening the valve if JP-5 is in the storage tank. The seawater detector interlock is bypassed when the stripping valve in the three valve interlocked drainage manifold is opened. Circuit monitors valve positions by open and shut lights on control console.

8. Circuit for selected JP-5 and drainage cutout valves. This circuit actuates the valves either open or shut by a switch on the console. Circuit monitors valve positions by open and shut lights on console.

9. Circuit for monitoring valve positions for valves that are manually operated and have limit switches at open and shut positions to actuate “open” and “shut” lights. Circuit actuates “open” and “shut” lights when in intermediate positions and shut off “open” light when valve is closed and shut off “shut” light when valve is open.

10. Circuit for starting and stopping JP-5 service pump. This circuit actuates the pumps to start and stop by a switch on the control console. Circuit monitors pump operation via “on” and “off” lights on control console.

11. Circuit for monitoring selected pump and purifier positions. The circuit actuates “on” lights when equipment is running and actuate “off” lights when equipment is not running.

12. Circuit for high level detector override. This circuit overrides the high level circuit of the tank level gage system to allow transferring fluid out of the tank or topping off the tanks to 100 per cent full.

13. Circuit for the electric motor operated JP-5 gate valves in shaft alleys No. 1 and 4. This circuit actuates the valves either open or shut by a switch on the forward console. Circuit monitors valve positions on both the forward and aft console by open and shut lights.

JP-5 FUELING SYSTEM OPERATIONS

LEARNING OBJECTIVE: Identify various JP-5 fuel system operations. Explain proper procedures for each operation.

Underway replenishment, transfer of fuel from one tank to another, and pumping fuel to the flight and hangar decks are everyday facts of life for the ABF. If proper procedures are followed, they are smooth and safe operations. If proper procedures are not followed, the operations become outright dangerous.

AVIATION FUELS OPERATIONAL SEQUENCING SYSTEM (AFOSS)

As stated before, though much of the equipment and operating procedures are similar from ship to ship, the fact is no two ships are alike. For this reason, the Aviation Fuels Operational Sequencing System (AFOSS) was developed to provide each ship with tailor made correct written technical operating procedures for the equipment installed on that specific ship. Every fueling evolution performed by the ABF will have an AFOSS procedure and that procedure MUST be followed.

AFOSS is developed into three operational stages. These stages are actually three copies of AFOSS designed around the purpose of each copy's use. They are as follows:

1. The Division Officer's copy
2. The Work center copy
3. The Work station copy

The Division Officer's copy contains the following:

1. An index page.
   a. Assigns each fueling evolution a title and number.
2. Step by step operating procedures for all evolutions concerning the fuels system.
3. A liquid level status diagram.
   a. Lists all tanks by tank number.
   b. Shows relative location.
   c. Indicates each tank's designation.
   d. Gives the capacity of each tank.
   e. Provides a space to show the current amount of fuel in each tank.
4. Training diagrams and charts.
   a. Shows each system.
   b. Indicates component locations.
   c. Gives the piping layout.
   d. Shows how different subsystems interrelate.

The Division Officer's copy is the master AFOSS for the division. It is used for training, scheduling and coordinating fueling evolutions, and insuring operations are properly conducted.

The work center copy is located in and applies only to a specific work center (flight or below decks) and contains the above information applicable to that work center only.

The work station copy is located in and applies only to a specific work station (JP-5 filter, JP-5 pump room, lube oil pump room) and contains the above information applicable to that work station only.

AFOSS operating procedures are prepared in a logical, detailed manner. They cover each fueling evolution and specific equipment used. They are also be used as a troubleshooting guide and as a reference for fuels casualty drills.

The operations discussed on the following pages are for training purposes and are based on typical procedures used during those operations. The specific procedures for operations aboard a particular ship will be in that ship's AFOSS. USE IT!

SOUNDING TANKS

While the tank level indicating equipment in use today is extremely reliable, the only 100% positive way to know how much and exactly what is in a tank is by sounding the tank. Sounding tanks is a simple procedure that has been used for as long as ships have sailed the sea. In the following paragraphs, we will discuss sounding equipment and procedures.

Sounding Equipment

Sounding tapes (fig. 4-49) are 50-foot steel tapes graduated in feet and inches (with the inches graduated to 1/8 's). The bitter end is fitted with a snaphook for attaching a plumb bob or thief sampler. The first 9 inches of the tape consists of the plumb bob and snaphook. These tapes are usually plain, but can be ordered in color, such as black on white or white on black.

Water-indicating and fuel-indicating pastes are available to assist in identifying positive "wet" marks on the tapes. Water-indicating paste will change color where the fuel/water interface occurs. Fuel-indicating paste will change color where the fuel/air interface occurs.

There are two types of thief samplers (shown in fig. 4-50). These samplers may be made up locally or obtained from a naval repair activity. Both can be used in a standard 1 1/2-inch diameter sounding tube. Type A is used where it is not necessary to obtain a sample from the very bottom. Type B can be used (if rigged properly) for any level or bottom sampling.

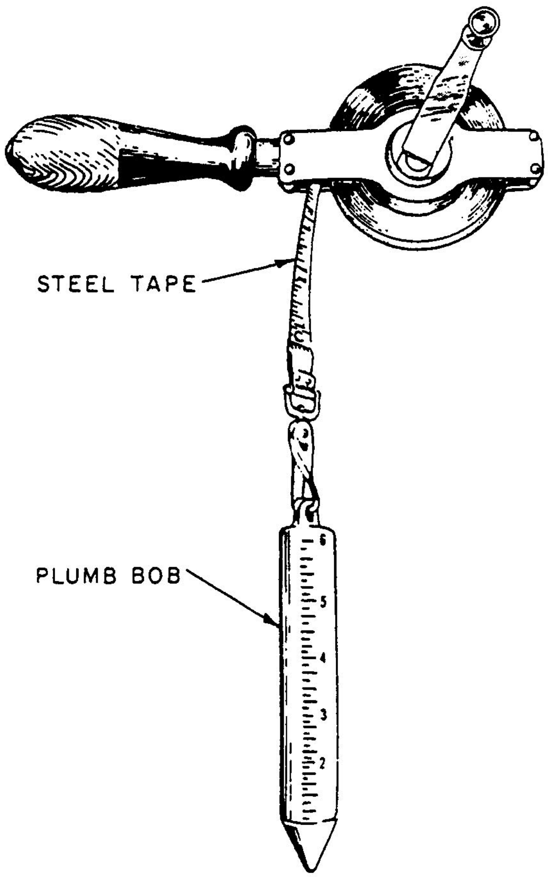


Figure 4-49.—Sounding tape.

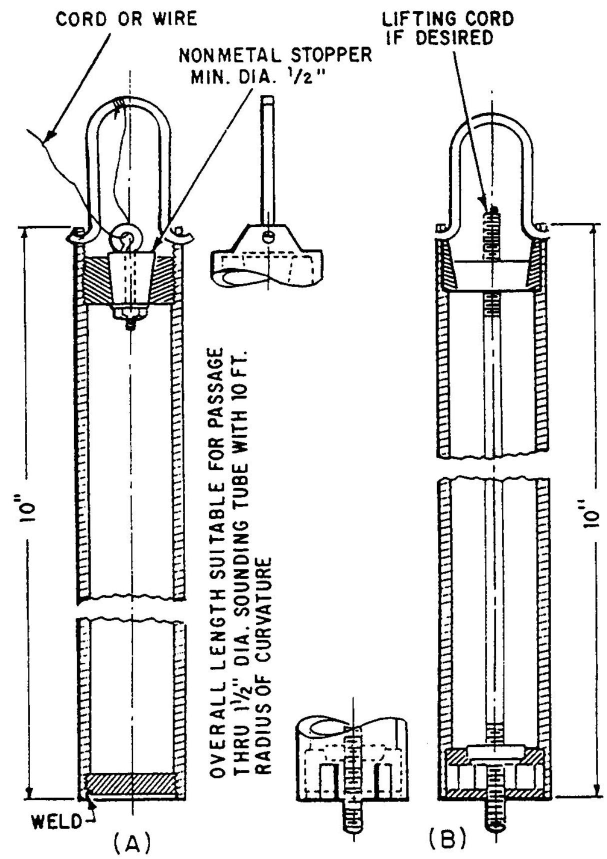


Figure 4-50.—Thief samplers.

Sounding Procedure

Spread a thin coating of water-indicating paste from the tip of the plumb bob to about the 2-foot mark on the tape. Lower the plumb bob through the sounding tube until, it touches the striker plate. The tape must be kept taut because slack would cause an inaccurate reading. Slowly withdraw the tape. The highest level where the JP-5 "wets" the tape is read in feet and inches. If the "wet" mark is difficult to see, use fuel-indicating paste. Dry the tape and spread a thin coating of the fuel-indicating paste in the approximate area of the first "wet" mark. When the tape is removed, note the line of color change on the fuel-indicating paste. This reading is then converted to gallons by use of a tank capacity chart. When the plumb bob is removed, note the line of color change of the water-indicating paste. The normal color, when applied, is gray. This level, in feet and inches, is converted to gallons and subtracted from the JP-5 reading to determine the quantity of JP-5 in the tank.

NOTE

The water-indicating and fuel-indicating pastes are different colors. They also change into different colors. They are NOT interchangeable.

To obtain a sample from the very bottom of the tank, remove the plumb bob and attach the type-B sampler shown in figure 4-50. Lower the sampler into the sounding tube. (The distance from the sounding tube cap to the striker plate will have been determined during sounding operations.) As the tip of the valve disk guide touches the striker plate, it will be depressed by the weight of the sampler, raising both upper and lower disks off their seat. After retaining this position momentarily, retract the sampler and dump the contents into a clean jar.

If water droplets or discoloration are noted on the sounding tape during the sounding and bottom sampling procedure, it is an indication of entrained or free water in the tank. Should this occur, it will be necessary to take a composite sample.

A composite sample is one in which samples are taken from different levels in the tank and mixed to form one sample. This type sample is more representative than one taken from only top and bottom. The same type sampler used to take the bottom sample can be used to take a composite sample, simply by attaching a string to the upper part of the disk guide stem. The sampler can then be opened at various levels by giving a smart jerk on the string. Tanks found to be contaminated with entrained water must be allowed more settling time before transferring.

RECEIVING JP-5 ABOARD

The first significant replenishing operation ever performed at sea by the U.S. Navy was in 1899, when the U.S. Navy collier *Marcellus,* while towing USS *Massachusetts,* transferred coal to her. Since that time, many methods and procedures have been tried and abandoned. Those described in this section are the typical procedures currently used in the fleet. The actual rigging of the replenishing hose between ships is the responsibility of the deck department and is not discussed. The ABF is concerned with only the filling connection hookup and the procedures for receiving JP-5 aboard.

The receipt of aviation fuel aboard carriers is a continuing problem in the fleet. This is due, in most part, to the hazardous nature of the fuel involved, and the ever increasing quantity required for our modern-day aircraft. Other factors of equal importance that also must be considered are the type and location of the operation, the time allotted, and the large number of personnel involved.

Time is an ever important aspect in any refueling operation, but more so at sea. The entire Task Force is scheduled to be replenished on a given date, and each ship is allotted a maximum time for this purpose. Not only are ships in constant jeopardy of a fire or collision during the replenishing operation, but they are also easy targets in the event of an attack.

JP-5 fuel is comparatively safe (having a minimum flashpoint of 140 F) when in its stored state. But, this same fuel handled under high pressure is extremely dangerous when released into the atmosphere in a fine mist or spray. Therefore, it should be treated accordingly, and every precaution should be taken to prevent the possibility of a fire or explosion when pumping this fuel.

A replenishing operation from a tanker was chosen to be described here since it covers all phases of any refueling operation.

The procedure for receiving JP-5 fuel aboard is basically the same for all class carriers. This section deals with the general procedures, equipment used, and the criteria for the acceptance or rejection of JP-5 fuel without reference to any particular ship.

The rate of fuel received is increased by using a double-hose rig. Two hoses are suspended, one below the other, from a single span wire. With this rig, two kinds of fuel maybe received simultaneously at a single station, or one kind may be pumped through both hoses.

Before receiving the tanker alongside, certain preparations are necessary to safely and efficiently expedite the replenishing operation.

Deballasting and Stripping

Any ballasted JP-5 tanks should be deballasted and stripped as soon as possible after the date and time of the replenishing operation have been confirmed. This requirement will be rare but must be covered in this section. Obtain assistance from personnel in the engineering department. They will align the main drainage system as required and operate the main drainage eductors.

The pump room or manifold operators align the tank stripping system as follows:

1. Unlock and open the main drainage cutout valve on the flood and drain manifold. (Relock manifold.)

2. Open the valves on the single-valved stripping manifold to the tanks to be deballasted.

NOTE

All tanks interconnected with one flood and drain manifold can be deballasted simultaneously. Each eductor can deballast an average of 1,000 gpm when supplied with fire main pressure of about 150 psi.

Because of the tremendous suction taken by the main drainage eductors, loss of suction on the tanks is most likely to occur before the tanks are completely emptied. When this occurs, realign the tank manifolds to use the tank stripping system as follows:

1. Close all valves in the single-valved stripping manifold.

valve and opening the stripping main suction cutout valve (relock the manifold valves).

3. Align the piping from the flood and drain manifold to the suction side of the motor-driven stripping pumps.

4. Align the motor-driven stripping pump discharge piping to pump into the contaminated settling tank or overboard (with the commanding officer's permission).

5. Open required valve on the single-valved stripping manifold.

6. Start the stripping pumps, and strip each tank one at a time until they are completely empty of all ballast water.

7. Secure the flood and drain manifold and close all valves in the single-valved manifold.

By use of the motor-driven stripping system, strip all storage tanks that are to be used in both the receiving operation and the internal transfer operation before receiving JP-5 aboard. Verify all stripping operations were successful by sounding the tanks, using water-indicating paste.

Strip the slack (partially filled) service tanks, using the hand-operated stripping system.

NOTE

Ships planning to replenish in port MUST deballast tanks before entering port.

Internal Transfer

Top off all slack service tanks. This will allow a longer settling time for the JP-5 being received. Consolidate the fuel load by transferring from slack storage tanks to completely fill as many tanks as possible. This will reduce the number of tanks to be filled and will minimize the number of tanks affected if contaminated fuel is received.

CAUTION

When fuel is to be transferred internally or received aboard, the overflow tank for every nest of tanks scheduled to receive fuel must be empty before fuel can be introduced into any tank in that nest.

Filling Sequence

Before receiving fuel, the JP-5 below decks supervisor should have soundings or readings taken on all storage and service tanks. A statement showing the amount and location of all JP-5 on board must be submitted to the V-4 division officer. It is the responsibility of the JP-5 below decks supervisor to know how much fuel is on board, where it is located, how much more can be received, the order in which the tanks should be filled, and the approximate duration of the receiving operation.

To determine the amount of JP-5 to be received, add the total capacity in gallons of each empty storage tank plus the amount required to top off any slack tanks. In determining the filling sequence, allow for a minimum of six tanks (three port and three starboard) on the line at all times. Knowing in advance the order in which the tanks will be filled will assist in the assignment of sounding teams, manifold operators, and the overboard discharge observers.

Three factors are involved in determining the duration of the receiving operation: the amount to be received (previously determined), the maximum receiving rate of the particular ship, and the normal pumping rate of the tanker. The latter two can be gained through experience and information recorded in the receiving log. But, if this is the first experience with the tanker, the pumping rate can be obtained in advance via radio messages to the tanker.

Personnel Preparations

A fueling watch list should be posted at least 24 hours before the refueling operation. In addition to the posted list, each man should be informed of his station and instructed in his duties. During the instruction period, emphasis should be placed on safety, emergency breakaway procedures, and other possible hazards. Assign only experienced and capable personnel to actually perform the duties. Limit the number of trainees, especially at the filling connections. Too many people at this station are not helpful and may confuse the operation by getting in the way. Whenever possible, rotate experienced personnel to other stations. This not only will give the individual the broadest training possible, but also will produce a more flexible division.

As a rule, fueling stations should be manned 1 hour before fueling time. The refueling stations to be manned and their locations are as follows:

1. Below decks office. This is where the below decks supervisor will coordinate the onload of fuel.

WARNING

Personnel working as overboard discharge watches and at the filling connections must wear a life jacket (kapok only), construction-type (safety) helmet or battle helmet, whistle, and pin-on marker light.

2. Overboard discharge watch. Located where required on catwalks, sponsons, or weather decks to observe and report the overflow from the overflow tanks.

3. Filling connection personnel (Repair personnel). Located at the filling connections on the sponsons.

4. Anticontamination sentry. Located in the AvFuels lab. Runners will be supplied to the sponsons to transport samples to the lab.

5. Sounding teams. Stationed where required. Sounding teams should be equipped with a sounding kit that contains the following:

a. Sounding tape (plumb bob safety-wired to tape).

b. Water-indicating paste.

c. Rags.

d. Pencils.

e. Tank sounding cards.

f. Flashlight (explosion-proof).

g. Sound-powered telephone headset.

h. T wrench (for sounding caps).

i. Spare gaskets (for sounding caps).

6. Manifold operators. Located in pump rooms or manifold spaces.

Preparations to be made on the refueling sponson by V-4 division personnel are not as numerous and time consuming as those below decks, since the actual rigging for receiving the tanker is the responsibility of the deck division. But, there are certain pieces of equipment that must be assembled by repair team personnel at or near the refueling sponson to safely and efficiently expedite the operation.

Repair team personnel should make sure the filling connection has a pressure gage, sampling connection. low-pressure air connection, and a flushing valve.

The equipment to be assembled at or near each refueling sponson by repair personnel includes the following:

- Proper handtools
- Drip pan
- Rags
- Swabs
- Buckets
- Five-gallon safety can
- Sound-powered phones
- Clean sampling bottles

The type and number of pieces of fire-fighting equipment to be laid out near the refueling station must be in accordance with the ship's fuel-handling bill.

Telephone talkers are stationed at the following locations on the 4JG circuit:

1. Below decks office
2. Filling connections
3. Flight deck control
4. Sounding tube locations
5. Overboard discharge watch
6. Pump rooms
7. Manifold spaces
8. Damage control central

All telephone headsets should be tested well in advance of the receiving operation.

Receiving Operation

Communications should be established immediately upon manning of a station. When all stations have reported manned and ready, the JP-5 filling and transfer system should be lined up for receiving JP-5. Open the following valves:

1. Below decks at the base of the downcomers to be used for the refueling operation.

2. All transfer-main bulkhead cutout valves.

3. Transfer-main branch header valves leading to the manifold of the tanks to be filled.

4. The transfer mainside manifold valves of selected tanks to be filled.

5. Tankside manifold valves of selected tanks to be filled.

NOTE

Deep centerline and double-bottom tanks are typically filled first during a refueling operation.

The below-deck piping and valves are now aligned for receiving JP-5 aboard.

Just before the tanker is received alongside, specific action must be taken by certain departments to ensure maximum safety and security during the replenishing operation.

The officer of the deck controls the smoking lamp. The operations watch officer makes sure certain high-frequency transmitters, radars, and other electronic equipment in the vicinity of the fueling stations are secured. The damage control watch officer ensures that additional firemain pumps are put on the line and that AFFF pumping stations are manned. The aviation fuels officer makes sure no mobile equipment or electrical winches (not required in the replenishing operation) are operated within 50 feet of the fueling station.

As the ship makes its final approach and steadies alongside, shot lines are sent over from each station. By these first lines, the telephone cables, distance line, and hose messenger are sent back. As soon as communication is established between stations, the JP-5 below decks supervisor clarifies with the tanker final information, such as the tanker's maximum pumping rate and discharge pressure and the earner's maximum receiving rate and pressure.

NOTE

The actual hookup of the fueling hoses is accomplished by personnel from the deck department.

The initial flow of JP-5 is received through the flushing valve and directed into the contaminated settling tanks. Before receiving JP-5 into the storage tanks, samples should be taken at the main deck fill connection in containers that permit visual inspection. If acceptable fuel is being received, open the downcomer and close the flushing valve. Start replenishment of aviation fuels at a slow rate.

When JP-5 enters the tanks, as indicated by the tank level indicators or sounding teams, order the tanker to start pumping at a normal rate. Log the starting time and continue taking samples to ensure the receipt of clean bright, water-free JP-5. Log the quality of the samples taken and pressure of the JP-5 being received at the filling connection.

The receiving pressure at the filling connection should be about 40 psi to obtain the designed maximum filling rate. CV/CVNs can typically receive JP-5 at a rate of 360,000 gallons per hour when using two stations.

As the storage tanks are being filled, you should check the volume of fuel in each tank by observing the tank level indicators and by sounding the tanks. In general, the tanks nearest the downcomer will fill first.

Begin sounding at the initial flow. Sounding should be taken periodically until the tanks reach 80 percent capacity. From this point on, soundings should be continuous.

When 80 percent capacity is reached in the first nest of tanks opened, open the tankside valve to another nest (minimum of six tanks-three port and three starboard) at the same time; throttle the TANKSIDE valves to the first nest of tanks; and top them off to at least 95 percent capacity. All storage tanks, except overflow tanks, can be filled to almost 100 percent to increase the amount of fuel carried on board.

All storage tanks in one nest, both port and starboard, can be opened for simultaneous filling, but care must be exercised when topping off to prevent overtaxing the overflow line.

CAUTION

Overflow mains for overflow tanks are typically designed for an overflow rate of 1,500 gpm, and each storage tank has an overflow rate of 500 gpm.

After the amount of JP-5 being received per minute has been determined, the tanker can be given an estimated "stop pumping" time.

All ships fitted with two or more downcomers can use any or all to expedite the refueling operation. The number of tanks that can be opened and the method of receiving will vary on the individual ships, depending on the number of personnel available as manifold operators, sounding teams, etc., and the experience gained after several refueling operations.

NOTE

An adequate number of contamination tanks must remain empty to receive the recirculated fuel from Cla-Val stations.

When the last port and starboard tanks to be filled reach 80 percent capacity, notify the tanker to reduce pumping. Top off the last tanks. When the overflow tanks reach 95 percent capacity, order the tanker to stop pumping.

After the tanker has ceased pumping, close the filling connection gate valve on the sponson.

At the completion of the replenishing operation, notify the officer of the deck of the start and stop pumping time and record the total gallons received. This information is entered in the ship's log.

Secure and restow all equipment. Close all valves in the filling and transfer system. The tanks should be sounded to obtain an accurate account of all JP-5 on board. During the final soundings, compare readings with the tank level indicators and adjust as necessary.

CRITERIA FOR ACCEPTANCE OR REJECTION OF JP-5.—The standards of fuel cleanness (table 4-4) are established as maximum limits for transfer of aviation fuels between shore activities and ships. Normally, contamination levels are maintained substantially below these levels.

Samples are taken continuously from the filling connection at the initial start of pumping until a clear sample is obtained. Thereafter, samples are taken every 15 minutes during the refueling operation. Any time a sample exceeds the contamination limits listed in table 4-4, the pumping operation must cease. The final decision of acceptance or rejection of the fuel rests on the commanding officer.

EMERGENCY BREAKAWAY.—During a refueling at-sea operation, any number of unforeseen circumstances could occur, making an emergency

Table 4-4.—Standards of Fuel Cleanness

From	To	Maximum sediment[1]	Maximum water[2]
Shore Tankage	Barges, Tankers, Fleet Oilers, Carriers	8.0 mg/liter	No visible
Fleet Oilers, Barges, Tankers	Carriers	10.0 mg/liter	No visible
Carriers, Fleet Oilers, Barges, Tankers	Shore Tankage	10.0 mg/liter	No visible

[1]Sediment levels are to be determined by laboratory analysis, or by the AEL Mk III Contaminated Fuel Detector.

[2]The free water content is determined by the AEL Mk I Free Water Detector Kit, and by laboratory analyses.

breakaway necessary. The order for an emergency breakaway may be given by the commanding officer of either the receiving ship or the delivery ship. Paramount in ordering an emergency breakaway is the allowance of sufficient time for the ships to disconnect the rigs in an orderly manner. Fueling rigs are subject to severe damage if not properly released at the breakaway signal, and serious injury to personnel could occur.

All emergency breakaway may be accomplished smoothly, rapidly, and safely if personnel at the station know how and what to do first. V-4 personnel on the refueling sponson should do the following:

1. After the tanker has stopped pumping, close the filling connection gate valve.

2. Clear the area.

Below decks personnel will secure the system as normal.

SETTLING AND STRIPPING

The storage period between receipt of JP-5 on board and delivery to an embarked aircraft is a vital link in the cleaning process required. This settling period, in addition to proper stripping, also will take the load off the other cleaning processes in the system. Therefore, it is extremely important for fuel handlers to be familiar with the settling and stripping procedures aboard aircraft carriers.

Settling Period

Use settling to the maximum degree possible to separate solids and water from fuel. The settling time for JP-5 is 3 hours per foot of product height. To obtain the maximum settling time for JP-5 tanks, the following operating procedures should be followed:

1. NEVER purify JP-5 into an IN USE service tank.

2. Completely empty the in use service tank before taking suction on another service tank.

3. Avoid agitating settled tanks by minimizing the transfer of JP-5 to consolidate the fuel load or to correct the list or trim of the ship. This can be prevented by following the proper emptying sequence and by taking suction from an equal number of port and starboard tanks simultaneously when transferring during normal operations.

4. Coordinate the replenishment date so there is always enough JP-5 on board to top off all service tanks before receiving JP-5 aboard.

5. When transferring JP-5 from storage to service tanks, the tank emptying sequence for any nest of tanks should be scheduled to empty the overflow tanks first, the slack tanks (if any) next, and the tanks that have had the longest settling time last.

Rotate the tank-emptying sequence between the different nests of tanks so all tanks are used and not just those that are most convenient to the pump-room operator.

Stripping Schedule

Serious contamination of JP-5 has occurred on several aircraft carriers, resulting in the loss of aircraft worth millions of dollars and, in some instances, loss of human life. All of this could have been avoided if WATER and SOLIDS in the fuel had not been allowed to reach the aircraft fuel cells.

This useless waste was caused mostly by improper use of the equipment, a lack of understanding of the need for stripping, and in some cases a complete disregard of the stripping equipment and procedure. Therefore, it is imperative that the following stripping schedule and procedure be complied with.

Strip the storage tanks with the motor-driven stripping pumps at the following times:

1. Before receipt

2. The day after receiving JP-5 aboard.

3. Weekly thereafter, as applicable

4. The day before purifying into service tanks

5. Immediately before purifying into service tanks

Strip the service tanks with the hand-operated stripping pumps at the following times:

1. Daily

2. Just before use

3. Weekly (in port)

Stripping Procedure

Before any transfer operation, the JP-5 storage tanks concerned must be stripped of all water and sludge by using the motor-driven stripping system.

The stripping system is aligned in basically the same manner as described for stripping ballast tanks. Proceed as follows:

1. Open the valve on the single-valved stripping manifold to the tank to be stripped.

2. Open the valve on the flood and drain manifold leading to the stripping main.

NOTE

Step 2 is necessary only for tanks that are designated JP-5 or ballast.

3. Open the necessary valves in the stripping main leading to the suction header of the stripping pump.

4. Open the stripping pump inlet valve.

5. Open the stripping pump discharge valve.

6. Open the cutout valve from the discharge header leading to the contaminated-JP-5 settling tank.

7. Start the motor-driven stripping pump.

Take frequent samples of the JP-5 being discharged. When a sample of clean, bright, water-free JP-5 is obtained, the tank is stripped. Close the valve on the single-valved stripping manifold, and open the valve to the next tank to be stripped. Strip all tanks in the same manner.

NOTE

The clean JP-5 remaining in the system between the single-valved stripping manifold and the stripping pump from the previously stripped tank MUST be discharged past the test connection before a conclusive sample can be obtained from the next tank to be stripped. This can be accomplished by having a general knowledge of the capacity of the stripping system piping between the two points and the capacity of the stripping pump. Run the pump accordingly. Allow extra running time for a safety factor. An example is, if the pipe capacity is 160 gallons and the pumps rated capacity is 50 gpm, then the pump should be operated for 4 minutes before a sample of the next tank is taken.

When all storage tanks have been stripped, stop the pumps and close all valves in the system.

The service tanks can be stripped in basically the same manner as the storage tanks by using the motor-driven stripping pumps. But, this should rarely, if ever, be necessary except when completely emptying the service tanks (the last 24 inches of fuel) before maintenance, cleaning, etc., and to remove the wash water after a cleaning operation.

If the storage tanks are allowed adequate settling time and are properly stripped, and if the centrifugal purifiers are maintained and operated properly, there should NEVER be enough water in a service-tank to require using the motor-driven stripping system for normal stripping purposes.

Service tanks are normally stripped by use of the hand-operated stripping pump. The procedure used is as follows:

1. Open the valve on the suction side of the stripping pump leading to the service tank to be stripped.

2. Open the valve on the discharge side of the stripping pump.

3. Operate the pump handle until clean fuel is observed in the discharge line (as indicated by the bull's-eye sight glass).

4. Open the test connection and take frequent samples. Pump until a sample of clean, bright, water-free JP-5 is obtained.

TRANSFER SYSTEM OPERATIONS

Transferring JP-5 internally is accomplished by the three individual transfer pumps in each of the forward and after pump rooms.

Transferring From Storage to Service

When transferring from storage to service tanks, use the following procedure:

1. Strip all tanks concerned, both storage and service.

2. Empty the purifier sump drain box.

3. Arrange the tank emptying sequence, Empty the overflow tank first, the slack tanks second, and the tanks that have had the longest settling time last.

4. Open the following valves:

a. Selected tankside manifold valves.

b. Selected transfer mainside manifold valves.

NOTE

Ensure that the telltale valves are closed.

c. All valves in the transfer main branch header between the manifolds and pump suction header.

d. Valves in the suction header.

e. The pump inlet and discharge valves to a designated transfer pump.

f. All valves from the pump discharge header to the designated purifier.

g. The service tank cutout valve to the tank to be filled.

h. The designated purifier discharge valve.

5. Start the purifier.

6. When the purifier attains 4100 rpm (146 to 150 bumps per minute), open the seal water plug valve on the purifier.

NOTE

To minimize vibration when starting with a dirty bowl, admit seal water immediately after pressing the stint button.

7. Open the main water-discharge observation port on the cover assembly. When water discharges past this port, close the seal water inlet plug valve on the purifier and at the supply end.

8. Start the designated transfer pump.

9. When the pump discharge pressure builds up, SLOWLY open the purifier inlet globe valve and throttle to maintain 9 psi inlet pressure. Then throttle the purifier discharge globe valve to maintain 30 psi back pressure (+or–5 psi).

10. Log the time the transfer pump and purifier were started.

11. While the system is in operation, make the following additional log entries:

a. Transfer pump inlet and discharge pressure.

b. Purifier inlet and discharge pressure.

12. Take inlet and discharge samples.

a. Send to the AvFuels lab to analyze with the AEL Contaminated Fuel Detector Mk III and the AEL Water Detector Kit Mk I.

b. Log the results of the analysis.

NOTE

It is advisable to take a visual sample of the contents of the storage tank from which suction is being taken at the initial opening of the manifold valves. This sample can be drawn through the telltale valve.

13. If the transfer pumps lose suction before the service tank is full, take the following action:

a. Close the purifier inlet valve.

b. Close the manifold valves to the empty tanks.

c. Place additional tanks on the line.

d. When the transfer pump discharge pressure is again attained, repeat step 10.

14. When the service tank is 95 percent full, secure the system The procedure for stopping the purifier is as follows:

a. Close the purifier inlet valve.

b. Stop the transfer pump.

c. Stop the purifier.

d. DO NOT engage the brake; the purifier will coast to a stop in about 45 minutes.

e. As the purifier slows down, centrifugal force diminishes, and inlet and discharge pressure will drop to zero.

f. When the flapper in the discharge sight glass stops, close the purifier discharge valve.

g. Close all valves in the falling and transfer system.

h. Make the following log entries:

(1) Time transfer pump stopped.

(2) Time purifier stopped.

(3) Gross gallons removed from storage tank.

(4) Net gallons received in service tanks.

During the transfer operation, samples for visual examination must be taken from the purifier outlet at regular intervals in accordance with local instructions. Samples must be clean and bright and contain NO free water. A cloud, haze, specks of sediment, or entrained water indicates the fuel is probably unsuitable and points to a breakdown in the purification process. Should this occur, the transfer operation must be secured until storage tanks concerned have been restripped; a clean, bright, water-free sample is received on the discharge side of the stripping pump; and the centrifugal purifier is inspected and discrepancies are corrected.

Transferring From Storage to Storage

This operation should rarely be necessary if an emptying sequence was properly established and followed (except when consolidating the fuel load before receiving). If and when this operation is called for, it will, in most instances, require transferring JP-5 from port to starboard, or vise versa, to correct the list on the ship; or transferring JP-S from forward to aft, or vice versa, to correct the trim on the ship.

The operating procedure for this operation is the same as transferring from storage to service with the following exceptions:

1. Purification and sampling procedures are not required.

2. The transfer piping from the discharge header of the transfer pumps is aligned to discharge into the opposite transfer main branch header, from which suction is being taken (when transferring from port to starboard, or vice versa), or to the transfer main (when transferring from forward to aft, or vice versa).

CAUTION

The overflow tank for any nest of tanks scheduled to receive fuel must be empty before JP-5 can be transferred into any tank in that nest.

Consolidating Fuel

When any transfer operation has been completed, consolidate to the greatest extent possible the last 24 inches of JP-5 remaining in the storage tanks. (As much as 5,000 gallons remain in some of the larger tanks after the transfer pumps lose suction.) This consolidation must be accomplished by the motor-driven stripping pump.

The procedure for consolidating the last 24-inches of JP-5 is the same as that outlined for stripping, except that the stripping pump discharge header is aligned to direct the discharged fuel into the transfer main instead of the contaminated-JP-5 settling tank.

From the transfer main, the JP-5 is directed into preselected storage tanks. Consolidated fuel should be allowed maximum settling time before it is stripped before use.

Ballasting Operation

The empty ballast storage tanks are ballasted (filled with sea water) to preserve the underwater protection system of the ship. Ballasting must be accomplished in accordance with current ship's ballasting instruction for each ship.

Tanks on CV/CVNs are ballasted by gravity through the sea chest valve on the flood and drain manifold and the single-valved stripping manifold. On LPHs and LPDs this water is supplied from the ship's fire main system.

Ballasting procedure is as follows:

1. Follow the tank falling sequence as scheduled by damage control central to maintain the proper list and trim of the ship.

2. Open the valves on the single-valved stripping manifold to the tanks to be filled.

CAUTION

Open an equal number of tanks on the opposite side of the ship.

NOTE

ALL tanks that are served by one flood and drain manifold can be filled simultaneously.

3. Align the valves on the flood and drain manifold for ballasting.

a. Unlock the sliding lock bar by loosening the two bolts over the oblong slots.

b. Position the lock bar so the circular hole in the keyhole slot is directly above the raised collar on the sea chest valve stem.

c. Rebolt the lock bar in position.

4. Open the sea chest valve.

5. Sound the tanks to determine the instant they are full.

6. As each tank becomes full, as indicated by the tank sounding teams, close the valve on the single-valved stripping manifold.

7. When all tanks are ballasted, close the sea chest valve and reposition the lock bar.

8. Lock the tankside valve (on the double-valved filling and suction manifold) in the CLOSED position.

9. Open the telltale valves on the double-valved manifold and drain the contents, then close these valves.

CAUTION

Thereafter, while the tanks are ballasted with seawater, periodically open the telltale valves to determine the condition of the tank-side valves and transfer mainside valves.

NOTE

Most ballast tanks will not fill completely. Some will only half fill due to tank height and draft of ship. Ballast liquid will seek its own level.

OFF-LOADING JP-5

When it is necessary to offload JP-5, the service pumps are used as transfer pumps due to their increased capacity. JP-5 is discharged off the ship via the transfer main, downcomer, filling connection, and then to a barge, tanker, or fuel farm. Since the service pumps are used as transfer pumps for off-loading JP-5, the piping and valves in the filling and transfer system and the service system must be aligned to enable the service pumps to take suction from, and discharge into, the same piping as the transfer pumps.

Assume, in this operation, that the entire fuel load is to be offloaded, including the JP-5 in the service tanks. This being the case, empty the service tanks first, since no special preparations are required to take suction from these tanks with the service pumps.

Off-Loading JP-5 From Service Tanks

Align the piping and valves as follows:

1. Open the service tank suction cutout valve between the service tank and the service pump suction header.

2. Open the service pump inlet valve.

3. Unbolt and rotate the spectacle flange (or line blind) to the OPEN position in the cross-connecting piping between the service pump discharge header and the transfer pump discharge header. Unlock and open the gate valve in this same line.

4. Open the valve between the transfer pump discharge header and the transfer main.

5. Open the transfer main bulkhead cutout valves leading to the downcomer.

6. Open the gate valve at the base of the downcomer.

7. Open the gate valve at the filling connection.

When topside preparations have been made for off-loading fuel, start the service pumps.

When pump discharge pressure reaches 80 psi, SLOWLY open the globe valve on the discharge side of the pump. Throttle pumps to avoid cavitating and maintain a minimum of 35 psi back pressure for automatic operation of pump motor controllers.

The service pumps are now taking suction from a service tank and discharging overboard via the service pump discharge header, transfer pump discharge header, and transfer main, up through the downcomer, and out the filling connection.

Continue the pumping operation as outlined above until all service tanks have been emptied. Then secure the pumps and align the system for emptying the storage tanks.

NOTE

The remaining 24 inches of JP-5 in the service tank are consolidated into preselected storage tanks by the motordriven stripping pump.

Off-Loading JP-5 From Storage Tanks

The piping arrangement from the service pump discharge header to the filling connection at the refueling station remains the same.

Align the piping from the suction header of the service pump to the storage tanks as follows:

1. Unbolt and rotate the spectacle flange or open the line blind valve in the cross-connecting piping between the service pump suction header and the transfer

pump suction header. Unlock and open the gate valve in this same line.

2. Open selected transfer mainside manifold valves.

3. Open selected tankside manifold valves.

NOTE

The suction headers for the service pumps are 8-inch to 10-inch lines, and all filling and suction lines to storage tanks are 5-inch lines. Therefore, an adequate number of tanks must be open at all times, or the service pumps will lose suction.

4. Open all valves in the transfer main branch headers leading to the suction header of the transfer pumps.

5. Start the service pump with the discharge globe valve closed. When the pump discharge pressure reaches 80 psi, SLOWLY open the discharge globe valve.

Continue pumping until all fuel has been off-floaded. Just as on-loading, when off-loading fuel, a tank emptying sequence must be followed to maintain the proper list and trim on the ship.

JP-5 SERVICE SYSTEM OPERATIONS

The operations described here for the service system include (1) flushing the service system, (2) fueling aircraft, and (3) defueling aircraft.

Before fueling any aircraft, the entire JP-5 service system must be thoroughly flushed after any one of the following occurrences:

1. After a shipyard overhaul (includes newly constructed or reconverted carriers).

2. After any major repair work has been accomplished on the JP-5 service system.

3. After drain back for maintenance.

The flushing operation is performed to rid the piping of the large quantity of solids and condensation that accumulate during the installation of and/or repairs to the system during a shipyard overhaul. Flushing also removes loose deposits of microbiological growth that can grow anywhere in the system where pockets of water exist.

Operation of the service system requires pumping large quantities of fuel at high pressure, therefore, every safety precaution must be adhered to.

The flushing operation is performed by pumping clean JP-5 through the service system piping from service tanks, via the service filter, through the distribution piping to every service station, and back into the contaminated settling tanks. The entire flushing operation can be accomplished with virtually no loss to the JP-5 fuel involved.

The piping arrangement and operating procedure between the pump room and the service stations for the flushing operation are practically identical as for fueling aircraft, which is to follow. To minimize repetition, the operation described here between the two points is for both operations.

The piping arrangement for one quadrant only is described here. Other quadrants can be aligned in the same manner.

Set up the pump room as follows:

1. Strip the in-use service tank.

2. Open the cutout valves in the suction line between the service pump and in-use service tank.

3. Aline the recirculating header to the service tank from which suction is to be taken.

4. Open the service pump recirculating line.

CAUTION

Ensure that the service pump discharge valve is closed.

5. Align distribution piping in the pump room.

6. Align the distribution piping in the filter room to activate the main fuel filter as follows:

a. Open the filter inlet and discharge valves.

b. Open the falter vent line.

c. Align the automatic water drain system.

d. Open both cutout valves leading to the forward and after legs of the outboard distribution main.

e. Open the port and starboard crossover cutout valve.

7. Align the first service station to be flushed as follows:

a. Open the service station riser valve and the cutout valve between the service station and hose reel.

b. Unreel all fueling hoses and attach the pressure fueling nozzle from one hose to the defueling main.

NOTE

The defueling main will have been opened to the contaminated settling tanks.

8. Start one service pump. When a discharge pressure of 80 psi is obtained, SLOWLY open the pump discharge globe valve. Observe the bull's eye sight glass in the filter vent. When a solid stream of JP-5 is discharging through this line, close the vent valves.

9. When the filter vent valve has been closed, start the service station defuel pump.

10. Close the nozzle toggle switch on the pressure fueling nozzle to place the service station in the fueling position.

Flush until a clean bright, water-free sample is obtained at the test connection on the pressure fueling nozzle. Analyze the sample using AEL detectors. Continue this operation on a station-by-station basis until each hose reel has been thoroughly flushed.

Fueling of aircraft is accomplished in the same manner as flushing the hoses, except that the nozzle is attached to the aircraft. **Specific flight deck procedures for flushing, fueling, and defueling are covered in chapter 5.**

AUXILIARY SYSTEM OPERATIONS

The auxiliary JP-5 system provides for the delivery of JP-5 to emergency diesel generators, small boat filling connections, and yellow gear fill stations. The procedure for transferring JP-5 to the auxiliary main is as follows:

1. Strip the selected service tank.

2. Open the tank top valve from the selected service tank and the cutout valve to the auxiliary pump suction.

3. Ensure all service tank valves not involved with the transfer operation are closed.

4. Open the valves in the discharge line from the auxiliary pump to the auxiliary main.

5. Open branch valves in the auxiliary system to the stations to be serviced, and check to ensure all branch valves for those stations not requiring servicing are closed.

6. Establish communications between the pump room and the stations to be serviced.

7. Start the JP-5 auxiliary pump.

8. When the transfer operation is complete, secure the JP-5 auxiliary pump and close all valves in its suction and discharge lines. Then close all open valves in the remainder of the system.

POLLUTION CONTROL

The Navy's ability to accomplish its mission requires daily operations on land, at sea, in the air—in other words, in the environment. The Navy is committed to operating its ships and shore facilities in a manner compatible with the environment. National defense and environmental protection are, and must be, compatible goals. The chain of command must provide leadership and personal commitment to ensure that all Navy personnel develop and exhibit an environmental protection ethic. Thus, an important part of the Navy's mission is to prevent pollution, to protect the environment, and to conserve natural, historic, and cultural resources.

Oil pollution is the Navy's largest single pollution problem. As ABFs, we have millions of gallons of petroleum products under our control at all times. **We are responsible for the safe storage and handling of every single gallon.**

OPNAVINST 5090.1A is the Navy's Environmental and Natural Resources Program Manual. In it, the Chief of Naval Operations provides specific guidelines and policies, assigns responsibility, and sets standards for the Navy to follow pertaining to environmental protection policies.

Some of the specific policies that concern the ABF are:

1. Oil or oily waste shall not be discharged from any naval activity or ship within 50 nautical miles of any shoreline in such quantities that will leave a sheen of the water.

2. Personnel will prevent or contain any accidental discharge to prevent pollution.

3. Provides procedures for the disposition of waste petroleum products.

4. Explains specific responsibilities of the chain of command for pollution abatement.

As an ABF, it is your responsibility to know and follow the Navy's pollution prevention policies.

SUMMARY

In this chapter, you have learned about the equipment and subsystems that make up the various below decks systems. You have learned typical operating procedures and minor troubleshooting.

The JP-5 Afloat Below Decks System is a vast, complex system that can be difficult to learn. A good training program will produce excellent results here. A key point to remember: If you follow the operating procedures in the equipment technical manuals and your ship's AFOSS, you can't go wrong. Supervisors should stress this point with junior personnel.